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SUMMARY OF FEEDING AND CONFINEMENT REARING EXPERIMENTS WITH TURKEYS DURING 1936

(Second Report)

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SECTION OF POULTRY HUSBANDRY AND LAKE CITY EXPERIMENT STATION

The feeding trials with turkeys under confinement conditions were continued during 1936 with some variations. The work of the 1935 season indicated the superiority of ration 7 as a diet for turkeys, as measured by normal development, growth rate, and finish. The trials with liquid milk were terminated at the end of that period. A complete account of the work of that year was reported in the Michigan Experiment Station Quarterly Bulletin, Vol. 19, No. 1, August 1936.

1936 Objectives

This year's feeding experiments centered around an attempt to reduce feed costs without limiting the development of the birds. The rations that were used and also the protein content of the mashes are shown in Table 1. Rations 8 and 9 include mashes of lower cost and somewhat lower protein content than rations 1 and 7, due primarily to the elimination of dried milk and the addition of corn gluten meal. The general plan, otherwise, was the same as that employed during 1935.

Table 1. Rations.

Ration	1	7	8	9
Protein Content of Mash	23%	26%	22%	22%
Ground yellow corn	19	9	14	19
Ground barley	—	—	—	15
Ground oats	17	15	16	14
Wheat bran	10	10	13	10
Wheat flour middlings	10	10	12	10
Corn gluten meal	—	—	10	5
Meat scraps	14	14	10	10
Soybean oil meal	10	22	15	7
Dried skimmilk	10	10	—	—
Alfalfa meal	5	5	5	5
Calcium carbonate	2	2	2	2
Salt	1	1	1	1
Cod liver oil	2	2	2	2
Total	100	100	100	100
To drink	water only	water only	water only	water only
*Grain	corn	corn	corn	corn
**Green feed	chopped alfalfa	chopped alfalfa	chopped alfalfa	chopped alfalfa
*Grit	gravel	gravel	gravel	gravel

*Yellow corn and gravel were added to the diet at the end of the seventh week.
**Chopped fresh alfalfa was given daily from the third week through the remainder of the experiment.

Incubation and Starting Methods

The poults used in this work were hatched in incubators at the poultry laboratory at East Lansing from eggs produced by the breeding flock of Bronze turkeys at the Lake City Experiment Station. The first trial was made with 150 poults hatched May 20, which was approximately two weeks later than the first trial of last season. Those were divided into five groups of 30 poults each for the duration of this experiment. A second trial was made with 148 poults hatched June 4. This second trial was approximately two weeks later than the first trial of this year and three weeks earlier than the second trial of last year. This difference in time should be considered in comparing the data of the two seasons.

As in the preceding year, the young poults were removed from the incubator when dry and placed in baby chick shipping boxes for the first 24 hours. At the end of that time they were placed under small brooders in the laboratory building in lots of about 40 poults each. Mash in hoppers, together with water in vacuum fountains, was the only food given for the first week, with the exception of a small amount of cooked egg which was added to the diet during the first five days. Infertile incubator eggs were hard-boiled and made fine by running through a potato ricer. This fine egg material sprinkled over the mash seemed to encourage early eating. Burlap was used for a floor covering for the first three or four days, until the poults were accustomed to eating mash, after which time bright chip shavings were used until the birds were removed to Lake City.

Experimental Pens at East Lansing

At the end of the first week the poults were sorted into five experimental lots of 30 each. Each lot was placed in an indoor pen, 4½ feet wide and 10 feet long, with an electric hover. Perches were added when the hovers were no longer required.

Because of the fact that this year the poults for the second trial were hatched only two weeks later than those of the first trial, it was necessary to remove the first lot of poults to quarters in a laying house to give the preferred location in the laboratory to the younger birds. This was done when the first group was two weeks of age. In this emergency arrangement each lot of poults was confined to a separate pen, 6 feet wide and 10 feet deep, after it had been thoroughly scrubbed, disinfected, and whitewashed. The birds remained in these quarters until removed to Lake City at the end of the seventh week.

The poults of the second trial remained in the quarters first mentioned until the end of the sixth week. With each trial it was necessary to keep the poults under the conditions described until their age and the weather conditions made it possible to transfer them to the large, open, turkey house at Lake City. Despite the exceptionally hot weather which prevailed during much of this early rearing period, the poults withstood this degree of confinement exceedingly well.

The Lake City Turkey House

At the Lake City Station, each lot of 30 turkeys was confined to a pen 10 feet wide and 24 feet deep in the open-front turkey house.

This building which is 100 feet long is constructed of farm-sawed lumber and poles. The house is divided into 10 pens with wire and wood partitions. At the end and back walls, are hinged panels that may be opened for summer ventilation. At the rear of each pen are perches and a dropping board. The floors are of concrete, and straw was used for litter. A view of this building is shown in Fig. 1.

Feeding Plan

In both trials, each of three of the pens of turkeys had its own distinct mash which was used for the entire period, and these are reported as Rations 1, 7, and 8, respectively, and correspond to the mash formula number. The two remaining pens each received a combination of two mashes. One of these pens received mash No. 1 until

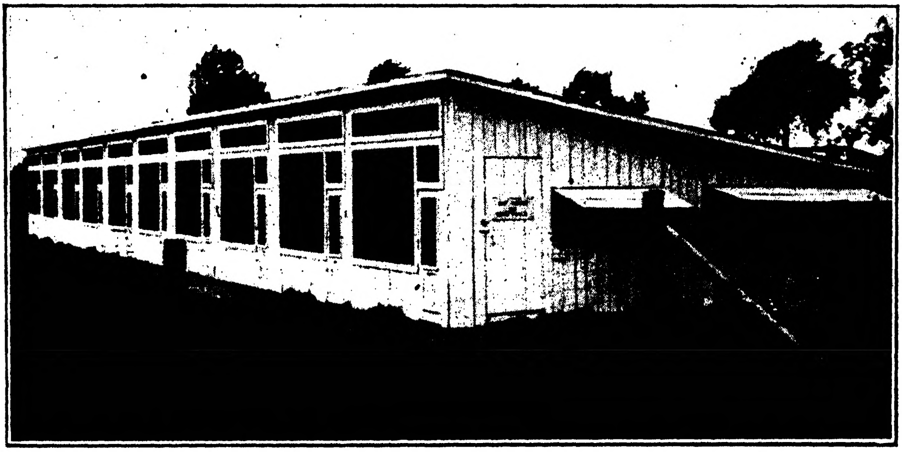


Fig. 1. Experimental turkey house, 24x100.

the end of the seventh week when a change was made to mash No. 9 and the pen was continued on this ration for the remainder of the 24 weeks. This pen is reported as Ration 1-9. The other pen similarly received mash No. 7 until the end of the seventh week when a change was made to mash No. 9 for the remainder of the period. This pen is reported as Ration 7-9. Mash, corn, gravel, and water were before the birds at all times at Lake City. Chopped fresh alfalfa was given daily in slatted racks.

Presentation of Results

Proportion of Mash and Grain Consumed Changes with Age—When given a free choice, there is a definite tendency for the birds receiving mashes of the higher protein levels to consume a smaller proportion of the mash and a greater proportion of the grain as they approach maturity than those on mashes of a lower protein level. This tendency is indicated by the data presented in Table 2.

Table 2. Proportion of mash and grain consumed.*

(Total mash and grain consumed equals 100)

Ration	Trial	0-4 wks.		5-8 wks.		9-12 wks.		13-16 wks.		17-20 wks.		21-24 wks.	
		Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain
1	1	100	None	100	None	98.5	1.5	90.3	9.7	77.6	22.4	50.9	49.1
	2	100	None	100	None	99.7	0.3	87.1	12.9	79.9	20.1	58.0	42.0
1-9	1	100	None	100	None	99.3	0.7	98.0	2.0	84.7	15.3	59.5	40.5
	2	100	None	100	None	99.9	0.1	99.6	0.4	79.1	20.9	63.9	36.1
7-9	1	100	None	100	None	99.4	0.6	96.3	3.7	85.0	15.0	60.7	39.3
	2	100	None	100	None	97.9	2.1	90.9	9.1	78.0	22.0	61.5	38.5
7	1	100	None	100	None	97.1	2.9	86.8	13.2	74.4	25.6	51.6	48.4
	2	100	None	100	None	98.4	1.6	82.4	17.6	71.6	28.4	52.7	47.3
8	1	100	None	100	None	99.4	0.6	92.0	8.0	80.9	19.1	53.6	46.4
	2	100	None	100	None	97.0	3.0	99.8	0.2	85.0	15.0	64.6	35.4

*Mash in hoppers from the start. Corn in hoppers after the seventh week, until the end of the period.

Feed Consumed Per Pound of Gain—One of the measures of the efficiency of a diet is the quantity of feed required to produce a unit of gain in weight in the birds. The average number of pounds of feed consumed per pound of gain is given in Table 3.

Table 3. Pounds of feed consumed per pound gain.

Ration	Trial 1					Trial 2				
	1	1-9	7-9	7	8	1	1-9	7-9	7	8
Mash	3.24	3.56	3.60	3.40	3.41	3.59	3.76	3.57	3.23	3.82
Corn	.96	.76	.81	1.09	.90	1.01	.78	.91	1.15	.71
Mash and corn total	4.20	4.32	4.41	4.49	4.31	4.60	4.54	4.48	4.38	4.53

Average Cost of Producing a Pound of Gain—In determining the merit of any ration, the cost of producing a unit of the product should be considered. This information is given for each of the trials and for each ration in Table 4. This table presents only the feed cost per pound of gain. Consideration should also be given to the normal development of the bird, the growth rate, physiological effect of the diet, the character of the finished product, and any other advantage or disadvantage of the particular ration before definite conclusions are drawn. There is a variation in feed costs from one year to another because of changing feed prices. The price of feeds during the 1936 season

was relatively high, having advanced about 20 per cent over the previous year. The cost of producing a pound of gain increased in like proportion.

Table 4. Feed cost per pound gain.

Ration	Trial 1					Trial 2				
	1	1-9	7-9	7	8	1	1-9	7-9	7	8
Mash....................	$.094	$.084	$.085	$.099	$.082	$.104	$.089	$.085	$.094	$.092
Corn....................	.021	.016	.017	.023	.019	.022	.016	.019	.024	.015
Mash and corn total.......	$.115	$.100	$.102	$.122	$.101	$.126	$.105	$.104	$.118	$.107

1936 Feed Prices—The prices paid for the different mashes and corn are shown in Table 5. The lower cost of rations 8 and 9 is due largely to the addition of corn gluten meal and the elimination of dried milk.

Table 5. Feed price.

Ration	Trial 1				Trial 2			
	1	7	8	9	1	7	8	9
Mash (ton)............	$58.00	$58.00	$48.00	$46.00	$58.00	$58.00	$48.00	$46.00
Corn (bu.)............	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20

Growth Rates—The average weights of both male and female turkeys at the end of the four-week periods are given in Table 6. The rate of growth of the different groups may be noted from the data presented.

Table 6. Growth of turkeys.
(Average weight in pounds)

Ration	Trial	4 wks.		8 wks.		12 wks.		16 wks.		20 wks.		24 wks.	
		M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
1............	1........	.69	.63	2.86	2.45	5.79	4.95	9.43	7.40	14.04	10.13	18.09	12.18
	2........	.57	.48	2.11	1.55	4.66	3.49	8.60	6.15	13.26	9.19	17.11	11.58
1-9..........	1........	.76	.64	2.70	2.15	5.09	4.16	8.52	6.63	12.99	9.68	17.17	12.29
	2........	.60	.57	2.06	1.66	4.16	3.30	7.73	5.79	12.07	8.79	16.09	11.14
7-9..........	1........	.74	.70	2.64	2.37	4.93	4.50	7.96	7.08	12.42	10.24	16.70	12.42
	2........	.76	.65	2.44	2.02	4.82	4.03	8.19	6.56	12.45	9.48	16.12	11.75
7............	1........	.74	.61	3.05	2.44	6.32	4.84	10.30	7.38	14.93	10.28	19.39	12.51
	2........	.72	.64	2.75	2.44	5.75	4.96	9.96	7.95	14.65	10.99	18.55	12.99
8............	1........	.76	.65	2.78	2.38	5.78	4.81	9.45	7.59	14.07	10.55	18.03	12.68
	2........	.60	.52	1.96	1.68	4.29	3.59	8.02	6.39	12.41	9.04	16.44	11.21

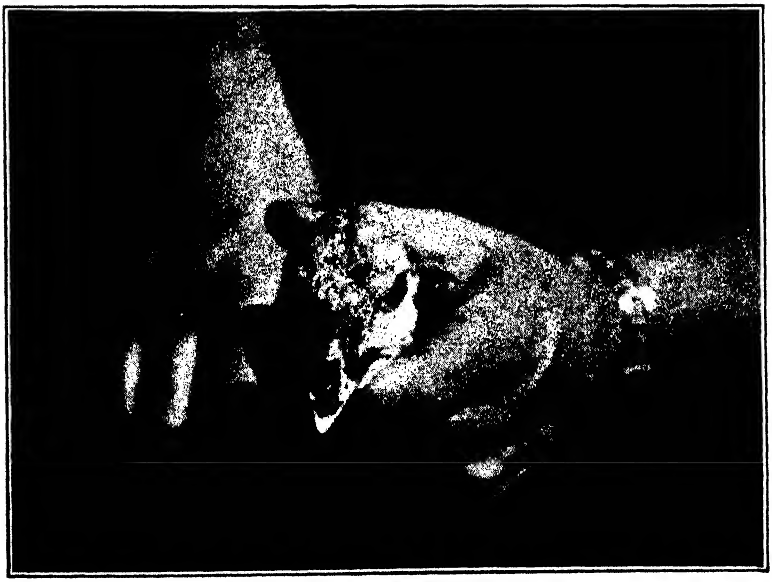
Mortality—The mortality during 1936 was slightly greater than during the previous year and the total loss was 12.4 per cent. Most of the loss occurred during the first 10 weeks when the weather was exceedingly hot. The temperature in the laboratory registered as high as 104° F. on several occasions. Only 4 birds died after the twelfth week.

Blackhead—A slight outbreak of Blackhead disease occurred in the first trial with the turkeys quartered in the laying house. It was realized that the hazard from this disorder was greatly increased in this location as the grounds and buildings had been used continuously for chickens for 14 years. Even though the buildings were cleaned and disinfected the possibility of bringing in contamination from the adjacent ground was great. The first loss occurred June 24 when a five-weeks-old poult on ration 7 died, and definite liver and cecal lesions of Blackhead were found on examination. Three or four other birds in this pen appeared out of condition at that time.

A treatment, using Iodine Suspensoid, was started at once with all of the pens on this trial and continued until the birds were removed to Lake City. As a result only three poults died of this disorder, and there was no outbreak in the other pens, even though it was necessary for the caretaker to enter all pens several times each day.

The treatment used is as follows: A stock solution in the proportion of 1 pound of Iodine Suspensoid (Merck) to 1 gallon of water was prepared. This was used at the rate of 2 ounces of the stock solution mixed with a moist mash for the 150 turkeys once each day (2/5 ounce per 30 birds). It was necessary to use sufficient added water to make a crumbly mash. Only a reasonable quantity of mash was used, such an amount as would be eaten in about 10 minutes. The treatment, recommended by Dr. W. L. Chandler of the Bacteriology Section, for the larger turkeys is as follows: ½ ounce of the iodine stock solution for turkeys weighing from one to two pounds, 1 oz. for turkeys weighing from two to five pounds and 2 oz. for birds over five pounds for each 30 turkeys, once each day in moist mash.

A Beak Disorder—An unusual beak disorder was observed in all 10 pens on August 8 when the turkeys were 9 and 11 weeks of age. Out of a total of 266 turkeys all but 12 birds were affected when examined on August 29. Shortly after that date the trouble subsided but it left deep scars and in some instances the loss of almost the entire beak. In nearly every case this disorder started on the top of the upper beak, immediately adjacent to the fleshy portion of the head, with a crusty, slightly elevated area. In many instances it advanced little farther than this. In other more severe cases it advanced along the top of the beak sinking deeper until much of the beak tissue was destroyed. Frequently these areas cracked, exposing raw tissue. The birds appeared active and in good condition otherwise. Even the birds that were more severely afflicted ate well and usually made good gains despite the handicap of the loss of part of their upper beak. No deaths were traceable to this abnormal condition. No account of this disorder could be found in the literature and the cause was not determined. Two stages of the most severe degree of this condition are shown in Figs 2 and 3.



Figs. 2 and 3. Stages of beak disorder.

Observations—The plumage characteristics of a bird give evidence as to the perfectness of the diet. Smooth, lustrous, richly colored feathers are characteristic of turkeys that are adequately nourished while rough, dull, gray, or weak plumage color is common with birds on an inadequate diet. The turkeys on ration 7 were the best appear-

ing birds in this respect with smooth, lustrous feathers of rich color. The birds on ration 1 were nearly as good but were not quite so smooth or colorful. The turkeys on rations 8 and 9 did not have the sleekness of the other birds, and gray feathers and rough plummage were common with them. This difference in plummage was noted as early as the third week with ration 8, and was most conspicuous during the early growth period.

Rations 8 and 9 tended to be slightly constipating while rations 1 and 7 were approximately normal in this respect.

Pendulous crop, which is an abnormal condition, appears at times to be influenced to some extent by the diet. Only five birds were noted as having some degree of pendulous crop and generally this was not serious or significant with any one ration.

Final Weights—There were 261 turkeys that completed the feeding trials. The turkeys on ration 7 were the outstanding birds as far as quality and finish were concerned. The birds on ration 1 were nearly as good. The birds on rations 8 and 9 would be rated as fair to good. There were only a few cases of crooked breasts and these were not significant on any one diet. The final weights of both males and females are given in Table 7.

Table 7. Final weights of turkeys in pounds at 24 weeks of age.

Ration	Trial 1					Trial 2				
	1	1-9	7-9	7	8	1	1-9	7-9	7	8
Surviving birds	29	28	29	26	26	25	21	26	25	26
Total weight	447.8	402.6	411.6	394.1	399.2	338.8	268.6	371.0	391.5	343.7
Number of males	16	12	12	10	13	8	7	15	12	10
Heaviest weight	19.8	20.7	19.2	20.9	20.8	19.0	19.0	18.9	21.6	18.3
Lightest weight	13.7	15.0	13.1	17.0	15.2	13.3	13.6	12.6	14.4	15.2
Average weight	18.09	17.17	16.70	19.39	18.03	17.11	16.09	16.12	18.55	16.44
Number of males	13	16	17	16	13	17	14	11	13	16
Heaviest weight	13.6	14.1	15.1	15.7	14.5	14.4	12.7	13.7	15.4	14.0
Lightest weight	10.8	8.2	10.2	9.6	10.2	7.7	7.5	10.1	11.4	7.3
Average weight	12.18	12.29	12.42	12.51	12.68	11.58	11.14	11.75	12.99	11.21

Summary

There is a definite tendency for turkeys on mashes of the higher protein levels to consume a greater proportion of grain as they approach maturity than those on lower protein mashes.

In every instance the turkeys on ration 7 were the best appearing birds with smooth, lustrous, feathers of rich color. Their gains were usually the best but not the cheapest. This is an excellent ration for starting baby poults and for the development of fine birds at moderate cost.

The turkeys on rations 8 and 9, while producing slightly cheaper

gains than those on rations 1 and 7, did not have the sleek appearance of the other birds. Gray feathers and rougher plumage were more common with them.

Rations 8 and 9 tend to be slightly constipating.

Ration 8, which was used for the entire period, did not prove to be a desirable starting ration. The young poults very soon developed a rough plumage with many gray feathers.

Only five birds were noted as having some degree of pendulous crop and generally this was not serious.

The price of mashes 1 and 7 and also that of corn was approximately 20 per cent higher than in 1935. The feed cost per pound of gain for this reason was approximately 20 per cent greater during the 1936 season.

1936 ONION PRODUCTION COSTS IN MICHIGAN

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SECTION OF FARM MANAGEMENT

Thirty-nine onion growers cooperated with the Farm Management Section in 1936 in a study of onion production costs and factors affecting net returns from the crop. These growers kept records on the hours of labor they spent on the crop, the hours and cost of hired labor, the cost of seed, fertilizer, hauling, the investment and expense on machinery and equipment used, and descriptive notes on conditions and cultural practices. From those records, the costs of production were determined for each grower and as an average for the group.

These growers had a total of 530 acres of onions, or an average of 13.6 acres per farm. According to the labor records, 240 hours of man labor were spent in the growing and harvesting of an acre of onions on those farms in 1936. To care for the average acreage on those farms required approximately 3,300 hours of man labor, and this does not include any of the work done by many in giving the onions a second screening after being put into storage. The average charge for the man labor in 1936 was $49.08 an acre (Table 1), figuring the hired labor at the rate actually paid and the grower's own time at 20 cents an hour, which was approximately the average rate paid. Thus, man labor charge made up 42 per cent of the total production cost of $117.54 an acre.

In figuring the charge for the use of the land, when the field was rented, the actual rent paid was used. If the land was owned, the owner's estimate of a fair rent was charged. The average charge was $19.97 an acre or 17 per cent of the total cost. The charge for the use of horses, tractors, trucks, and other machinery and equipment in 1936 amounted to $19.19 an acre or 16 per cent of the production cost. Commercial fertilizer applications, like hours of man labor spent and most other items, varied considerably from farm to farm, but averaged 781 pounds and $13.62 cost per acre. This was about 12 per

cent of the production cost, while seed cost was 7 per cent and other items 6 per cent of the total in 1936. Thus, it is evident that opportunities for reduction in cost are greatest in the labor, power and machinery items.

Table 1. Onion production costs in Michigan, 1934, 1935 and 1936.

Item	1934	1935	1936
Number of farms	25	40	39
Acres of onions per farm	8.1	18.0	13.6
Yield per acre in bushels	438	210	404
Planting date (average)	May 1	Apr. 29	Apr. 29
Seed used per acre (lbs.)	4.1	4.2	4.0
Fertilizer per acre (lbs.)	666	739	781
Man hours per acre	288	293	240
Horse hours per acre	16	5	2
Tractor hours per acre	8	5	7
PRODUCTION COSTS PER ACRE:			
*Man labor	$55.09	$51.12	$49.08
Horse and tractor use	7.22	3.64	6.23
Machinery use	7.90	7.31	12.96
Seed	6.64	11.00	8.84
Commercial fertilizer	14.57	14.85	13.62
Land use	19.52	17.60	19.97
Miscellaneous	.81	.40	1.24
Overhead	5.59	5.93	5.60
*Total	$117.34	$111.85	$117.54
*PRODUCTION COST PER CWT.	.52	.99	.54
MARKETING COST PER CWT.	.08	—	—
Total	$0.60	—	—

*Does not include any management charge. Cost per 100 pounds is field-run.

In addition to presenting the average costs and returns in 1936, Table 1 also shows the results for the two years preceding. In 1935 the total growing and harvesting cost on farms where records were kept was $111.85 an acre, even though the average yield was only 210 bushels. In 1934 the production cost totaled $117.34 an acre on a yield of 438 bushels. Therefore, the cost of 100 pounds of field-run onions put in the farm storage by growers keeping records was 54 cents in 1936, 99 cents in 1935, and 52 cents in 1934. To this must be added storage and other marketing costs if the cost is to be compared with selling prices. The average yield on these farms during the three years was just 3 per cent above the state average of all growers.

Comparison of High- and Low-Cost Farms—Production cost on those farms ranged from 27 cents to $1.50 per 100 pounds of onions. The 10 low-cost farms, all having a cost of less than 43 cents a hundred and averaging 32 cents were compared with the 10 high-cost farms, which had costs exceeding 67 cents and averaging 76 cents per 100 pounds. Table 2 shows that the cost per hundred was lower on the low-cost group because the cost per acre averaged one-third less than that of the high-cost group, and the yield per acre was more than 50 per cent higher. One of the principal reasons for the lower cost per acre was in the lower labor expense. There was less than one-half as much time spent in weeding and wheelhoeing on the low-cost farms as on

the high-cost. There was less investment expense for machinery and equipment on the low-cost farms, principally because of difference in crates. Other cost items averaged less also on the low-cost farms. The only apparent reason for the higher yield of the low-cost group was a seemingly more productive muck soil.

Table 2. Comparison of onion costs on high and low-cost farms, 1936.

Item	10 Low-cost farms	10 High-cost farms
Acres of onions per farm	12.1	14.6
Hours of labor per acre	134	244
Yield per acre in bushels	480	308
PRODUCTION COSTS PER ACRE:		
*Man labor	$26.88	$51.93
Horse and tractor use	3.98	7.15
Machinery use	6.35	18.00
Seed	4.76	9.74
Commercial fertilizer	13.28	12.88
Land use	22.94	17.50
Miscellaneous and overhead	4.19	9.30
*Total production cost	$82.38	$126.50
Growing cost per acre	57.98	93.54
Harvesting cost per acre	24.40	32.96
PRODUCTION COST PER CWT:		
Growing	.22	.56
Harvesting	.10	.20
*Total production cost (field-run at farm)	$0.32	$0.76

*Does not include any management charge.

Hours of Labor of Operations—Complete data on hours of labor by operations on 34 of the farms (Table 3) show that 55 per cent of the 259 total hours of man labor per acre were spent in weeding and wheelhoeing, while 40 per cent was required for topping, screening once and hauling to the farm storage. Thus, it is apparent that if the labor charge of one-half the total cost is to be reduced, the reduction must be in one or both of these phases of the work. Thorough preparation of the seedbed before seeding, destroying all weeds, should do much to reduce the expense of weeding and wheelhoeing. Perhaps topping machines and power graders can lower the cost of topping and screening.

Table 3. Labor on onions by operations on 34 farms, 1936.

Operation	Hours per acre:			
	Man	Horse	Tractor	Garden tractor
Cleaning ditches	1.3	.3	0	0
Plowing, fitting and seeding	10.0	1.1	6.1	.4
Weeding and wheelhoeing	142.0	.1	0	3.8
Topping, screening and hauling	106.2	.8	.8	0
Total	259.5	2.3	6.9	4.2

INFLUENCE OF TYPE AND AGE IN FATTENING CATTLE

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The data presented in this article were obtained from a second trial of the test comparing beef-bred and dairy-bred calves for fattening purposes. The initial trial was reported in Vol. 19, No. 1 of the Quarterly Bulletin. The additional lot of yearling steers fed in the previous trial was omitted due to financial stringencies.

Considerable numbers of both kinds of calves are raised on Michigan farms and large numbers of beef-bred calves are shipped in for feeding purposes each year. The majority of dairy-bred cattle seem to come to market at an older age. Data in the previous trial and also data from other sources indicate the greater efficiency in the feed-lot of the younger cattle.

Object and Plan

The object was to compare the feeding efficiency and the economic returns from the two types of calves. Block tests and carcass analyses are being conducted to complete the picture, but, the data are not available at the present time.

The dairy-bred calves in the previous trial were lighter weight and apparently younger than the beef-bred calves. In attempting to get them fully as heavy in this trial, the dairy calves proved to be heavier. Calves were scarce on the markets, while yearlings were plentiful. Holstein breeding was distinctly predominant with only two steers indicating roan or brindle tinges of color. Eight calves were purchased in Detroit and two near Sandusky.

The Hereford calves were purebred from the Sanilac Stock Farm, near Sandusky.

The cattle in each lot were started on feed December 2 and were fed 183 days, or until June 3, 1937. Each lot received similar proportions of shelled corn, corn silage, and alfalfa hay. Cottonseed meal was fed at the rate of one-fourth pound for each 100 pounds of live weight. Each lot was given as much feed as would be eaten readily twice daily. One pig was placed in each lot to pick up the undigested grain. Values of pig gains were used to reduce the feed cost on the cattle.

Weights and Gains

The average initial weights are indicated in Table 1, the Hereford calves weighing 405 and the Holsteins 484 pounds when the test began. The Hereford calves gained more slowly, especially in the beginning, averaging 2.25 pounds per day, or a total of 411 pounds. The Holsteins gained rapidly the first three months but more slowly later, averaging 2.39 pounds per day, or a total of 437 pounds. The weights

Table 1. Beef type vs. dairy type calves for fattening weights, feed, market values and feeder steer values.

December 2, 1936–June 3, 1937—183 days—10 steers per lot	Hereford calves	Holstein calves
Average initial weight ... lbs.	405.	484.
Average final weight ... "	816.	921.
Average total gain ... "	411.	437.
Average daily gain ... "	2.25	2.39
Average daily ration:		
Shelled corn ... lbs.	7.4	9.
Cottonseed meal ... "	1.4	1.5
Corn silage ... "	12.9	15.9
Alfalfa hay ... "	3.2	3.5
Feed for 100 lbs. gain:		
Shelled corn ... "	327.	376.
Cottonseed meal ... "	61.	65.
Corn silage ... "	575.	666.
Alfalfa hay ... "	144.	147.
Feed cost for 100 lbs. gain, cr. pork:		
1936–37 prices ...	$10.99	$12.43
Average prices ...	7.25	8.13
Financial Statement—1936–37 prices:		
Feed-lot price, fat cattle, June 10, 1937 ...	$11.50	$9.375
Fat steer per head—June 10 ...	93.84	86.34
Feed cost—cr. pork—per steer ...	45.19	54.32
Interest on feeder steer at 6% per annum ...	1.42	.93
Feeder steer—value remaining ...	47.23	31.09
Feeder steer value per 100 lbs. ...	11.49	7.11
Financial Statement—Average prices:		
Feed-lot price of fat cattle ...	$8.00	$6.00
Fat steer—per head ...	65.32	55.28
Feed cost—cr. pork—per steer ...	29.83	35.56
Interest on feeder steer at 6% per annum ...	1.03	.57
Feeder steer—value remaining ...	34.46	19.15
Feeder steer value per 100 lbs. ...	8.38	4.38

1936–37 prices: Corn $1.26 bu., $45 ton; cottonseed meal $50; silage $6; alfalfa $10 ton. Pork credit $11.

Average prices: Corn 70 cents bu., $25 ton; cottonseed meal $40; silage $4.50; alfalfa $12.50; pork $8.

on June 3 were 816 pounds for the Herefords and 921 pounds for the Holsteins. The Herefords gained rapidly during the last two or three months, and appeared to fatten a great deal. The Holsteins appeared to reach their peak earlier. Whether this difference was due to differences in weight and age or to inherent differences in the cattle is not known.

Feed Consumption and Costs

The average daily ration and the feed for each 100 pounds gain on the cattle are indicated in the second part of Table 1. As stated above, the same proportions of feed were fed in each lot as nearly as possible. There was a difference in the feed consumption in the two lots, the Holstein calves eating approximately one-fifth more feed than the Herefords. While the Holstein cattle in Lot 2 were eating more feed per day, they were not gaining sufficiently fast to pay for the extra

feed. About 15 per cent more feed was eaten to produce each 100 pounds gain in weight on the Holstein calves.

The cost of gain has been computed on the basis of two different feed prices, that for prices prevalent during the time of the experiment and also with feed prices representing somewhat average conditions. These prices are indicated at the bottom of Table 1, and the cost of gain is indicated in the third division of the table. After crediting the gain made by pigs, the cost of the feed eaten while 100 pounds gain in weight was produced was $1.44 higher for the Holsteins with 1936-'37 feed price levels, or 88 cents higher under average conditions.

1937 Cattle Values

Market values of cattle also change, depending on conditions of supply and demand. Market values were placed on the cattle on Feeders' Day at the College, June 10 by representatives of the Detroit, Buffalo, and Chicago markets. One dollar per 100 pounds was deducted from the price to obtain the value in the feed lot as given in division 4 of Table 1. The white-faced calves, valued at $11.50, were $2.125 per hundred pounds higher priced than the lot of Holstein cattle.

Deducting interest charge on the feeder steer and the cost of feed from the selling value of the fat steer on June 10 leaves the value per head of the feeder steer. If no other charges are made, the prices indicated in the bottom line of part 4 in the table could have been paid for the feeder cattle in the fall in the feed-lot, namely, $11.49 per hundred pounds for the white-faced calves in Lot 1, $7.11 for the Holstein calves in Lot 2. Other charges and credits that may be made in the complete accounting would doubtless be approximately in proportion to the weight of the cattle, or similar per 100 pounds of steer in either of the lots.

Average Prices and Costs

In the last part of Table 1 are given data from average prices for cattle and for feed. The feed prices indicated are similar to those prevalent in many parts of Michigan over a term of years. The average fat cattle prices for steers of these grades are taken from a three-year average from the Bureau of Economics' report of cattle prices in Chicago, with deductions for marketing expense. The three-year average indicates a price of $8.00 for the white-faced cattle and $6.00 per hundred pounds for the Holsteins, the same prices as used in a similar computation in the trial of the previous year.

Deducting the cost of feed and interest as previously discussed and disregarding other costs and credits, the values for the feeder steers on the basis of the three-year price for fat cattle are, as shown in the bottom line of the table: $8.38 for the Hereford calves, and $4.38 for the Holsteins. The values per head are $34.46 and $19.15.

These values compare closely with those in the previous experiment: $8.75 for the Herefords and $4.59 for the Holsteins.

Grades of Cattle

All of these cattle and carcasses were graded by members of the Animal Husbandry Department on charts devised in cooperation with

the United States Department of Agriculture and other experiment stations making studies concerning quality in meat. The white-faced cattle graded mostly choice, and the most of the Holstein cattle were graded medium, as tabulated in Table 2. Six months is doubtless longer than most medium grade steers are fed as a usual practice, but an attempt was made to compare those cattle after a period of similar treatment on feed. The dressing percentages were noticeably different, as indicated in Table 2, the Holstein cattle showing 3.05 per cent lower dressing percentage than the white-faced calves. The dressing percentage, however, is not enough to account for the difference in market price. The carcasses lacked covering on the outside and lacked the thickness and shapeliness of a desirable beef carcass. Retailers and discriminating consumers prefer the appearance of the beef-bred carcasses and cuts.

Table 2. Cattle and carcass grades and dressing percentages.

	Hereford		Holstein	
	Slaughter cattle grades	Carcass grades	Slaughter cattle grades	Carcass grades
Choice (No. cattle)	8	9	0	1
Good	2	1	3	3
Medium	0	0	5	6
Common	0	0	2	0
Average dressing percentage (Weight at slaughter and cold carcass weight)	Cold—61.64 per cent		Cold—58.59 per cent	

Carcass analyses are being made and palatability tests were taken with these cattle as additional data to supplement feeding and market data.

Summary

Holstein calves weighing 484 pounds gained more rapidly during a six-month feeding period than Hereford calves weighing 405 pounds.

The Holstein calves ate more feed and required approximately 15 per cent more feed for each 100 pounds gain in weight. The increase in cost of gains was $1.44 at 1936-'37 prices, or 88 cents at average prices for feeds.

Sale values of the fat cattle of $11.50 and $9.375, respectively, for the Herefords and Holsteins, make possible feeder steer prices of $11.49 and $7.11 if no other charges, credits or profits are considered except feed costs, interest on feeder steer and pork credits at 1936-'37 prices.

Under average price conditions, if the fat cattle in the two lots are worth $8.00 and $6.00, respectively, possible feeder steer prices of $8.38 and $4.38 per hundred pounds, or $34.46 and $19.15 per head are evident.

VARIED AMOUNTS OF CORN AND ALFALFA FOR FEEDER LAMBS

L. H. BLAKESLEE AND G. A. BROWN
SECTION OF ANIMAL HUSBANDRY

In what proportions should corn and alfalfa be fed lambs to obtain maximum gains? Can the feeder increase the proportion of alfalfa when the cost of corn is abnormally high, as during the feeding season of 1936-'37, and still obtain good gains? These and other questions are often asked by lamb feeders and should be carefully considered since corn and alfalfa constitute the standard lamb ration. Furthermore, a feeder should use the combination which will give him not only the most rapid gains but in addition, economical gains and finish at the desired time.

A two-year test at this Station involving 130 feeder lambs fed corn and alfalfa in three different proportions, gives some of this desired information.

The lambs were given a preliminary week's feed of average quality first cutting alfalfa alone and as the test started, shelled corn was added and increased to the desired proportion within the first two weeks. As in all other trials at this station, the feeder was instructed to reduce the hay allowance only when the weigh-back taken at each feeding exceeded 20 per cent of the hay fed. Therefore, the lambs were allowed to pick out the leafy and most nutritious parts of the hay, leaving the coarse stems. When this weigh-back was deducted the actual daily consumption of hay was 1.28 pounds, 1.45 pounds and 1.87 pounds for lots 1, 2 and 3, respectively, as shown in Table 1. All lots were hand-fed twice daily and given free access to water and a mixture of equal parts of feeding steamed bone meal and salt. The following are the rations fed to the respective lots.

Lot 1 was full-fed shelled corn and first cutting alfalfa hay in approximately equal parts by weight.

Lot 2 was fed 1 part of shelled corn to 2 parts first cutting alfalfa hay with corn limited to 1 pound per head daily the first 56 days and then raised to 1¼ pounds.

Table 1. Hay fed, refused and daily consumption with proportions of hay and corn.

	Lot 1	Lot 2	Lot 3
Hay fed per lamb per day..............lbs.	1.62	1.98	2.47
Hay refused per lamb per day.......... "	.34	.53	.60
Hay consumed per lamb per day........ "	1.28	1.45	1.87
Proportion of corn to hay fed..............	1 part corn 1.27 parts hay	1 part corn 2 parts hay	1 part corn 3 parts hay
Proportion of corn to hay consumed........	1 part corn 1 part hay	1 part corn 1.36 parts hay	1 part corn 2.25 parts hay

Lot 3 was fed 1 part shelled corn to 3 parts first cutting alfalfa hay. Shelled corn was limited to ½ pound per head daily the first part of the feeding period and then raised to one pound.

While rations fed were as near as possible to the foregoing standard, adjustments necessary during the experiment changed the proportion of corn and alfalfa as indicated in Table 1.

Table 2 gives the comparative results and shows that there was little difference in the rate of gains. However, this slight difference of 0.02 pound per lamb daily made it necessary to feed the lambs in Lot 3, receiving a large amount of alfalfa, nine days longer to obtain the same weight.

Table 2. Summary of results. Average of two trials. (1934-'35, 1935-'36).

	Lot 1	Lot 2	Lot 3
Total number of lambs fed	42	44	44
Average number of days fed	99	99	108
Average initial weight ... lbs.	63.2	62.8	62.8
Average final weight ... "	94.8	94.7	95.1
Average gain per lamb ... "	31.6	31.9	32.3
Average daily gain per lamb ... "	.32	.32	.30
Average daily ration:			
Shelled corn ... "	1.27	1.06	.83
Alfalfa hay ... "	1.62	1.98	2.47
Feed fed per cwt. of gain:			
Shelled corn ... "	394	327	276
Alfalfa hay ... "	505	609	822
Feed fed per lamb:			
Shelled corn ... "	124	104	89
Alfalfa hay ... "	160	195	266
Feed cost per cwt. of gain:			
Shelled corn $45 per ton; Alfalfa hay $10.00 per ton	$11.40	$10.41	$10.32
Shelled corn 15 per ton; Alfalfa hay 7.50 per ton	4.84	4.73	5.15
Shelled corn 25 per ton; Alfalfa hay 12.50 per ton	8.09	7.90	8.59
Shelled corn 35 per ton; Alfalfa hay 17.50 per ton	11.32	11.05	12.02

All lambs were graded by commercial graders in Detroit when sold and in the carcass after slaughter. As shown in Table 3 there was practically no difference between lots in shrinkage during shipment, dressing percentage or in carcass grades of lambs.

Table 3. Shrinkage in shipment, dressing percentage and carcass grades.

	Lot 1	Lot 2	Lot 3
Shrinkage in shipment ... per cent	3.6	3.6	3.9
Dressing percentage ... "	50.4	48.5	49.5
Prime and choice ... number	31	33	33
Good ... "	10	9	11
Medium ... "	1	2	—
Total ... "	42	44	44

Since alfalfa is the principal farm feed to market or convert into manure through lambs, a careful study of the relative value of rations used in each lot follows.

When lambs are worth $9.00 in the feed-lot and all returns credited

to feed, lamb feeders can charge $9.10 per ton for hay and the lambs will return $38.20 per ton for corn. However, if hay is charged at more than $9.10 per ton, it is more profitable to feed similar to Lot 2; if charged at less than $9.10 per ton, it is more profitable to feed similar to Lot 3. In other words, corn must be worth more than 4.2 times the value of hay before it is more profitable to feed similar to Lot 3, and less than 4.2 times the value of hay before it is more profitable to feed similar to Lot 2, according to data obtained in these trials.

Feeding similar to Lot 1 becomes more profitable than feeding similar to Lot 2 when corn is worth less than 1.5 times the value of hay. Some difficulty was experienced in getting Lot 1 lambs to consume 1.5 pounds of corn per head daily which was set as a tentative standard. This lot of lambs was rather erratic in their consumption of feed and two were lost due to digestive troubles, all of which seems to indicate full-feeding with corn and alfalfa is not as satisfactory as feeding 1 part corn and 2 parts alfalfa, and less profitable unless corn is worth less than 1.5 times hay as previously pointed out.

Summary

1. Lambs fed 1 part shelled corn and 2 parts first cutting alfalfa made the most economical gains in this trial.

2. Lambs fed equal parts of shelled corn and first cutting alfalfa hay made good gains. This ration proved more economical when corn is worth less than 1.5 times per ton that of alfalfa hay.

3. Shelled corn and first cutting alfalfa fed in the proportion of 1 to 3 produced good but slower gains, and proved more expensive, except when corn is worth more than 4.2 times per ton as much as alfalfa hay.

CONTROL OF NORTHERN FOWL MITE

J. A. DAVIDSON AND RAY HUTSON*
SECTIONS OF POULTRY HUSBANDRY AND ENTOMOLOGY

In January 1936, the northern fowl mite, *Liponyssus sylviarum*, made its first observed appearance in the College pullet flock consisting of 3 pens of Barred Rocks and 8 pens of White Leghorns. It was first observed in a pen of White Leghorns having "pik-gards" attached to the beaks for the control of cannibalism and feather picking.

The northern fowl mite, *L. sylviarum* Canestrini and Fanzago is a small grayish or reddish mite commonly found infesting robins. It also occurs on other wild birds. This mite can be identified beyond doubt by microscopic examination. It differs from most other mites found on domesticated fowls in that it remains upon the birds most of the time.

*J. M. Merritt, Graduate Assistant in Entomology, aided greatly in the experimental work.

L. sylviarum is characterized by having an undivided dorsal plate which does not cover the upper surface of the body; three pairs of setae upon the sternal plate of the female; and a single pair of setae upon the genito-ventral plate. It can be separated from its near relatives by the presence of a single pair of long setae at the posterior end of the dorsal plate.

Dr. W. L. Chandler, college parasitologist, suggested the use of an orthophenylphenol dust (35%) and accordingly the birds were all dusted January 25 and 26 with approximately ½ ounce each of dust. This was placed in the feathers of the abdomen, back and underneath the wings. In addition to this, four birds in laying cages were dusted with the same preparation using amounts up to 2 ounces per bird at two-day intervals. Little, if any, reduction was noted in the number of mites present on the birds.

Orthophenylphenol (50%) also was used on birds in laying cages as well as sodium fluoride. No satisfactory results were obtained with either.

On February 10 the results of the orthophenylphenol dust was checked as follows:

Pen 1—White Leghorns—not individually handled and examined.
Pen 2—White Leghorns—not individually handled and examined.
Pen 3—Barred Rocks—not individually handled and examined.
Pen 4—White Leghorns—not individually handled and examined.
Pen 5—Barred Rocks—30% infested with mites.
Pen 6—White Leghorns—100% infested with mites.
Pen 7—Barred Rocks—30% infested with mites.
Pen 8—White Leghorns—30% infested with mites.
Pen 9—White Leghorns—30% infested with mites.
Pen 10—White Leghorns—30% infested with mites.
Pen 11—White Leghorns—not individually handled and examined.

After examination on February 10 the birds in the designated pens were treated in the manner shown in Table 1.

The temperature was low in the houses during this period and undoubtedly volatilization of the 40 per cent nicotine sulphate,** naphthalene and P. D. B.* was low. These were applied to the perches; the nicotine sulphate as recommended for lice, and the other two as suspensions in cottonseed oil, using a pressure-type grease gun such as is used in greasing automobiles. Dri-Kill and sulphur were used as dusts. The birds were individually handled and examined February 29th.

Table 1.

Pen	Treatment Feb. 10	Per cent Infested Feb. 29
1	Nicotine Sulphate one treatment	Mites on males only
2	Nicotine Sulphate one treatment	Mites on males only
3	Napthalene flakes in vaseline	5.4
4	No treatment	3.0
5	Naphthalene grease on perches	34.0
6	Dusted with Naphthalene	14.0
7	Naphthalene grease on perches	33.0
8	Sulphur dusted	0
9	P. D. B. on perches	7
10	P. D. B. on perches	50
11	No treatment	6

*Paradichlorobenzene.
**Black Leaf 40.

Table 2 indicates dates of treatments administered between February 29 and the examination March 31.

Table 2.

Pen	Treatment Feb. 29 or as indicated	Per cent infested Mar. 31
1	None	Males only
2	None	Males only
3	None	70
4	None	30
5	Naphthalene Mar. 12-12-16	80
6	None	70
7	Mar. 10-12-16 P. D. B	80
8	None	16
9	40 per cent nicotine sulphate Mar. 10	40
10	40 per cent nicotine sulphate Mar. 10	10
11	40 per cent nicotine sulphate Mar. 10	4

The results presented in Tables 1 and 2 indicate that P. D. B. and naphthalene as used were ineffective. In addition, they were greasy smears on the plumage. Sulphur was easy to use, effective, and did not smear the plumage; 40 per cent nicotine sulphate gave indication of reducing the infestation.

Accordingly on March 31 the birds were again treated as shown in Table 3.

Table 3.

Pen	Treatment Mar. 31	Number infested Apr. 15
1	None.	
2	None.	
3	Naphthalene dust	All not handled—mites present
4	Sulphur on infested only	30
5	Naphthalene dust	82
6	Naphthalene dust	70
7	Naphthalene dust	100
8	Sulphur on infested birds only	15
9	Sulphur on infested birds only	44
10	Sulphur on infested birds only	5
11	Sulphur on infested birds only	None.

It will be noted that in every case sulphur decreased the infestation.

After it became apparent that wherever 40 per cent nicotine sulphate was used the mites did not increase rapidly although entire elimination did not take place, the thought that three applications a few days apart of 40 per cent nicotine sulphate might be effective occurred. On April 15-17-21 an application on the perches as recommended for lice was made. This proved to be entirely effective as observed on May 1 when all the birds were handled for weighing. This is in approximate accordance with the practice recommended by Bishopp and Wagner (Jour. Econ. Ent. 24 (1930) and Payne (Jour. Ec. Ent. 22 (1929) of three applications three days apart of Blackleaf 40.

In November 1936, another outbreak of mites occurred and this treatment proved effective.

The sulphur has been tried on birds in laying cages where it is difficult to use 40 per cent nicotine sulphate and proved effective upon one application.

Summary

An application of 40 per cent nicotine sulphate put on the perches in the manner prescribed for lice is an effective means of controlling the feather mite if three applications at three-day intervals are used.

Sulphur generously applied to the individual bird is an effective control where it is impossible to use 40 per cent nicotine sulphate on perches.

Other materials used might be effective if different methods of application of more time consuming nature were used.

The treatment of all birds is necessary for satisfactory results.

LAND USE AND SOIL CONSERVATION PRACTICES IN LENAWEE COUNTY

E. B. HILL AND H. B. TAYLOR
SECTION OF FARM MANAGEMENT

To assist in the development of a better state and national program for agriculture a farm management study was made of 97 farms in Hudson and Medina townships, Lenawee County, in 1936. This survey was a part of the national study of interregional competition in dairying in the north central and eastern states. It was made in cooperation with the Bureau of Agricultural Economics of the United States Department of Agriculture. A total of 78 farms were also studied in Mecosta county where the milk was all sold on a butterfat basis in the form of cream.

Information was obtained relative to the receipts and expenses of the farms, the crop and livestock organization and practices, the labor, the farm investments, and the soil conservation needs and practices. The records covered the year ended April 30, 1936. The farms included in this survey were livestock farms on which dairy cattle were the principal source of income. Much of the milk was marketed as whole milk at local condenseries and at plants in Detroit, Toledo, and Cleveland. The principal feed crops grown were hay, corn, and oats. Wheat was grown mostly as a cash crop.

Land Use—The 97 farms included in this study ranged in size from 40 to 500 acres and averaged 152 acres per farm. The average size of all farms in Lenawee County, according to the 1935 census, was 95 acres. On an average, 60 per cent of the land in this study was owned by the operators. Man labor was equivalent to an average of 1.8 man per farm.

The tillable land on these farms comprised about 74 per cent of the total land operated and was used as follows: hay 21 per cent, pasture 19, corn 19, oats 18, wheat 13, soybeans 3, idle and fallow 3, and other crops 4 per cent.

In order that a study might be made of the influence that the acreage of hay and pasture on a farm had on various farm practices, the

farms were sorted into two groups: (1) Those farms having less than 30 per cent and (2) those farms having 30 per cent or more of their rotation land in hay and pasture. By this classification there were 48 farms in the low percentage group with an average "hay and pasture land percentage" of 22 per cent (Table 1). The high group comprised 49 farms with an average "hay and pasture land percentage" of 41 per cent. Thus, the farms in the high group had 70 per cent more rotation land in hay and pasture than the farms in the low group.

Table 1. Land use on 97 Lenawee county farms as influenced by the proportion of rotation land in hay and pasture, 1935.

Item	Percentage of Rotation Land in Hay and Pasture	
	Less than 30	30 or more
Number of farms	48	49
Per cent of rotation land in hay and pasture	22	41
Acres of land operated	157	147
Acres owned	67	114
Acres rented	90	33
Acres of tillable land	117	108
Per cent of tillable land in:		
Hay	16	27
Corn, grain	20	16
Corn, silage	3	3
Wheat	16	11
Oats	19	15
Soybeans	4	1
*Other crops	3	3
Rotation pasture	3	9
Permanent pasture	13	13
Idle and fallow	3	2
Acres of non-tillable land	40	39
Per cent of non-tillable land in:		
Permanent pasture	38	36
Woods pastured	30	28
Woods not pastured	5	13
Farmstead and waste	27	23

*"Other crops" includes sugar beets, rye, buckwheat, cucumbers, and truck crops.

Crop Yields—The average crop yields for 1935 on the farms in this study were about the same as the yields normally expected. Compared with the 10-year average yields for Lenawee County, the yields of corn, small grains, and potatoes in 1935 were greater on the farms in this study. Crop yields were about the same on farms in the low "hay and pasture land percentage" group as on farms in the high group.

Amount of Livestock—Dairy cattle made up 58 per cent of all the productive livestock. The total amount of livestock per farm was about the same on farms in the low "hay and pasture land percentage" group as on farms in the high group (Table 2). There was a difference, however, between the farms of the two groups in the amounts of the different feeds fed to livestock. For example, farmers having a high percentage of rotation land in hay and pasture fed their cows 66 per cent more hay, 4 per cent more silage, 28 per cent less dry roughage other than hay, and 22 per cent less concentrates

Table 2. Amount of livestock on 97 Lenawee county farms as influenced by "hay and pasture land percentage," 1935.

Item	Percentage of Rotation Land in Hay and Pasture	
	Less than 30	30 or more
Number of farms	48	49
Acres per farm	157	147
Number of livestock:		
Dairy cows	10.6	9.4
Ewes	9.2	18.2
Hens	114	91
Sows	1.5	1.9
Horses	2.7	3.0
*Number of animal units:		
Dairy	15	13
Sheep	2	4
Poultry	3	2
Hogs	3	5
**Other productive livestock	1	1
Total productive livestock	24	25
*Tillable acres per productive animal unit	4.7	4.5

*An animal unit is considered to be the amount of livestock equal to one mature horse or cow, based primarily on feed consumption.

**Other productive livestock includes colts and other cattle.

than did the farmers in the low group. The number of cows per herd averaged 9.4 for the high percentage group and 10.6 for the low group. The number of pounds of butterfat equivalent sold per cow was 216 for the high percentage group and 228 for the low group.

The Dairy Enterprise—For all farms in this study, the dairy herds averaged 10 cows. The butterfat production per cow averaged 248 pounds. Feed costs were estimated to be 64 per cent of the value of the milk produced. The returns per $1 feed fed averaged $1.57. The 14 large herds with an average of 19.2 cows averaged 225 pounds of butterfat equivalent sold per cow during the year which was 25 pounds of butterfat per cow more than that sold from the 11 small herds which averaged 3.6 cows.

Operator's Age and Experience—The average age of the operators on the farms in this study was 49 years. The average age of the 42 men who owned their farms was 55 years while the 27 men who were renting averaged 43 years (Table 3). Thus an average difference of

Table 3. Operator's age and experience in farming, Lenawee county, 1936.

Item	Type of Tenure		
	All owned	Owned and rented	All rented
Number of farmers	42	28	27
Age of operator, years	55	46	43
Number of years as a tenant	3	8	13
Number of years as an owner	15	16	2*

*Some of the farmers had lost their farms and were renting in 1935.

12 years existed between the ages of farmers who operated only their own land and farmers who operated only rented land.

Farms Indebtedness—There were 70 farmers in this study who owned all or a part of the land they operated. Forty-two of the farmers owned all of the land they operated. Of those 42 owners there were 24 who reported an indebtedness which averaged $3,850 per farm. This amounted to 40 per cent of their total farm investment. Since 18 of the 42 owners reported no debts, the average indebtedness for all owners was 22 per cent of their total investment. Of the 28 farmers who owned farms and rented additional land, 14 reported an indebtedness which averaged $2,526 per farm. This amounted to 28 per cent of their total farm investment. Since 14 of the owner-renters reported no debts, the average indebtedness for the 28 owner-renters was 14 per cent of their total investment.

Financial Summary—The average cash receipts for the year ended April 30, 1936 for 91 of the farms in this study was $2,495 per farm. Of this amount 82 per cent came from livestock, 13 per cent from crop sales, and 5 per cent from other receipts. The cash expenses per farm averaged $1,591 and were made up as follows: farm improvements 8 per cent, machinery and equipment 25 per cent, livestock 27 per cent, feed expense 13 per cent, crop expense 9 per cent, hired labor expense 10 per cent, and other farm expenses 8 per cent. The returns for family labor and capital were $1,531 per farm. Of this amount, however, $172 was allowed for unpaid family labor other than operator's labor, $544 for interest on the investment at 5 per cent, which left $815 for the operator's labor and management. In the same area the average operator's labor and management wage for 66 farm account farms was $1,566. In neither of the two groups was the value of farm products used by the household included in the farm earnings.

The 45 farms in this study with less than 30 per cent of their rotation land in hay and pasture averaged $892 per farm for labor and management. This was $153 more than for the 46 farms with a high "hay and pasture land percentage". The farms in the low group, however, averaged 11 acres larger than the farms in the high group. All of the receipts and all of the expenses except for hired labor were greater on the farms in the low percentage group than on the farms in the high group. The greater hired labor expense on the farms in the high group was offset by the smaller allowance for unpaid family labor.

Conservation Practices—The federal Soil Conservation Program is a subject of much interest and concern to farmers. Therefore some information was obtained in this study regarding a few of the farm practices that had a direct bearing on soil conservation such as use of lime, fertilizer, and manure; extent of soil erosion; hay and pasture establishment for 1936; and changes in crop and livestock production practices.

During the 1936 crop season, 79 of the 97 farmers included in this study used commercial fertilizers on at least one crop. The land receiving such applications amounted to 20 per cent of the rotation land on all farms (Table 4) The crops for which fertilizers were applied included corn, wheat, oats, rye, barley, soybeans, sugar beets,

potatoes, beans, and truck crops. Nearly two-thirds of the fertilizer used was of a 2-12-6 analysis. The average cash cost of fertilizer alone was $2 per acre of treated land.

Six of the 97 farmers made applications of limestone or marl (Table 4). The total land treated amounted to slightly more than one per cent of all rotation land. Of the six farmers who used limestone or marl, four were doing so for the first time. The cash cost of the limestone and marl alone was $1.90 per acre of treated land.

Land to be planted or already planted in corn, wheat, or alfalfa received the major portion of the stable manure. Some land growing each of the other crops was also treated including a considerable acreage of land in permanent pasture. An average of approximately 162 tons of manure per farm was hauled from the barns and feeding lots back to the land (Table 4).

Table 4. Commercial fertilizer, limestone, marl, and manure practices on 97 Lenawee county farms, 1936.

Item	Kind of Treatment		
	Commercial fertilizer	Limestone and marl	Manure
Number of farms using treatment	70	6	97
Total rotation acres (97 farms)	9,531	9,531	9,531
Acres treated	1,953	111	1,718
Acres treated per farm (average for 97 farms)	20	1	18
Application per acre treated	148 lbs.	2 tons	9 tons

According to the 97 farmers visited in this study, 84 per cent of the land on their farms had not shown any signs of erosion. The validity of such statements, of course, depends upon the interpretation placed by the farmers on the term "erosion". In most instances "sheet erosion" is not noticed by the average farmer and not until gullies begin to appear does he consider his soil as being subject to erosion. In 1935, tillable land constituted about 74 per cent of all land and about 40 per cent of this tillable land was in sod crops. In other words, about half of the total land operated in 1935 was in row and grain crops. Therefore, it is probable that there was more soil erosion on many of these farms than was observed.

Approximately 16 per cent of all tillable land was seeded in 1936 to hay and pasture. This was about the same as was usually seeded. The acreage of the different kinds of seedings in 1936 were also about the same as usual. Alfalfa and sweet clover together made up 61 per cent of the total seeding in 1936.

A total of 50 farmers indicated that they had made changes in their cropping practices since 1930. Those changes, expressed as a percentage of the 1930 acreage, were as follows: (1) Increases—legume hay 23 per cent and wheat 2 per cent; (2) decreases—non-legume hay 32 per cent, small grains other than wheat 3 per cent, and corn 2 per cent. The acreage of rotation pasture had remained about the same. Thirty-five farmers indicated that they were planning some changes in crop production. The more important changes, expressed as a percentage of the 1935 acreage, were as follows: (1) Increases—wheat

10 per cent and legume hay 10 per cent; (2) decrease—non-legume hay 17 per cent.

The indicated changes since 1930 in the numbers of livestock on the farms in this study, expressed as a percentage of the 1930 numbers, were as follows: (1) Increases—hens 15 per cent, ewes 6 per cent, cows 2 per cent and beef cattle 145 per cent; decrease—sows 25 per cent. Although the percentage changes in beef cattle and sows are large, their significance is relatively small because of the small total numbers of beef cattle and sows on the farms. The farmers were planning still further to increase the numbers of livestock on their farms as follows: cows 20 per cent, hens 41 per cent, sows 16 per cent, and ewes 17 per cent. They were planning a slight decrease in beef cattle.

Twenty-three farmers in this study considered increasing the size of their farms either by renting or by purchasing. Such an increase was desired by most of those farmers in order that they might raise more feed or make better use of family labor. Additional land as desired was available at reasonable terms in practically all cases. Thirteen farmers considered decreasing the size of their farms either by renting-out or by selling. Some of those farmers wished to dispose of land that was located at an undesirable working distance from home. Others were anxious to retire because of poor health or old age.

STERILIZATION OF APPLE JUICE BY FLASH PASTEURIZATION

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During the course of the past season's investigations designed to test and develop methods of processing apple juice for off-season consumption, the writers, on Feb. 2, 1937, ran a lot of previously clarified and filtered fresh apple juice through a flattened-tube flash heater or pasteurizer and into bottles which were crowned as soon as filled.

When samples of sterile cider made by various processing methods were examined and tasted a few days later by a group of the Michigan State College staff, that subjected to the flash pasteurization was the unanimous choice for appearance and was rated the best for taste by most of the group while others rated it second or third among 10 lots of juice. Subsequently, parties interested in the commercial processing of apple juice sampled this lot of cider and pronounced it "very good," "excellent," "the best sterilized cider I have tasted," "good apple flavor". These parties were asked whether any "cooked," "scorched," "caramelized" or "jelly-like" taste was detected. A few stated that none was detectable while most of those people detected a slight cooked taste that they considered unobjectionable and not likely to be noticed by the consuming public. All agree that it was much

superior in this respect to that pasteurized in the bottle at 170° F. for 20 to 30 minutes.

Other lots of clarified and filtered apple juice were processed by the same general method February 18, March 2, 12, 30, and April 18. All of the bottles filled with hot juice and crowned with sterile caps on those dates have retained a good "live" cider color, have remained free from sediment deposition, and none has shown evidence of the presence of any microorganisms such as molds, yeasts and bacteria even though half of each lot of bottles has been stored at approximately 70° F. for 10 to 20 weeks.

Bottles of the various lots of flash pasteurized apple juice have been examined and tasted by several groups of individuals and the reactions have been so satisfactory that it seems advisable to publish the rather preliminary results and a description of the process at this time.

Steps in the Treatment

Each lot of cider was made from six varieties (including Grimes, Northern Spy, Baldwin and Rhode Island Greening) of clean, sound apples. The apples were subjected to the usual grinding and pressing. Pectinol, an enzymic clarifying agent, was stirred into the juice at the rate of 16 to 20 ounces per 100 gallons of juice. The juice was then allowed to stand for some 15 hours to allow the clarifying agent to do its work. The cider was then transferred to a supply tank for filtering, care being taken to save the sediment-laden juice in the bottom of the clarifying container for the last of the filtering operation. "Hyflo Super-cel" was mixed with the juice at the rate of approximately 2 pounds per 100 gallons and the mixture was forced through a special fruit juice filter under a pressure of 4 to 10 pounds per square inch. Detailed directions for the treatment of this stage appear in an earlier publication of the Michigan Experiment Station (2).

The clarified and filtered juice, at temperatures ranging from 50 to 70° F., was then fed by gravity or pumped at low pressure to the flattened-tube flash pasteurizer. The rate of flow, and thus the time subjected to heat, was varied during the course of most of the runs. The length of time that the juice remained in the heated, flattened tube varied from 5 to 15 seconds for most of the runs, but some bottles were filled with cider that remained in the heated tube for as long as 40 seconds, and others for as short a time as 5 seconds. The 7 to 10-second heating produced a sterile product while longer heating merely increased any tendency toward a cooked taste. The temperature of the juice as it left the flattened-tube heating unit was maintained at 190 to 195° F. throughout a greater portion of each run.

Neither equipment nor bottles were sterilized when the juice was conducted from the heated, flattened-tube unit directly into the bottles. The bottles were filled completely and crowned as quickly as possible. These bottles were allowed to cool gradually and in cooling formed a vacuum.

The pasteurizer was constructed with two units, one for heating the juice and a second that could be employed for flash-cooling immediately after heating and before bottling. When the juice was cooled before bottling, the whole juice-conducting system, the bottles

and the crowns were sterilized with steam or with a chlorine solution before operation. The most satisfactory method for sterilizing the juice-conducting system seemed to be that of running a solution containing 300 parts per million chlorine through the apparatus for 10 to 15 minutes. At the end of this time, the outlet to the bottles was closed and the chlorine solution allowed to stand in the system until the temperature of the flattened-tube reached 190 to 200° F. The apple juice was then started through the system and the first few pints discarded. This method prevents any possibility of recontamination after sterilization, unless the temperature of the heating unit should drop much below 190° F. The bottles and crowns were sterilized in 300 parts per million chlorine for at least 20 minutes before filling with juice. The greatest source of contamination when handling cooled juice is at the place where the cider leaves the end of the tube or rubber hose and enters the bottle. An inverted glass hood such as an inverted funnel is advisable to prevent downward current of microbial-laden air from entering the bottle with the juice stream. Furthermore, this processing should be done in a small bottling room that can be kept very sanitary by spraying the ceiling, walls, floors, and equipment with a strong chlorine solution. The work herein reported was done in a large fruit handling laboratory and under very unfavorable conditions for handling cool juice. There was no spoilage in two lots of bottles processed in this way, but all bottles of juice showed mold contamination in one run and about half the bottles developed mold mycelium in the other runs. Thus, this method is not recommended except under very favorable conditions for bottling. None of the bottles processed in this manner developed a cooked taste that would be detected by any but those persons having the most sensitive tastes.

It is essential that apple juice be clarified and filtered to free it of sediment and suspended colloidal material before it is subjected to flash pasteurization. Otherwise, the juice will have a pronounced cooked or scorched taste and the product will be rather unattractive.

The apple juice pasteurized during the course of these studies was sealed in glass beverage bottles of various sizes. The process, however, is well adapted to sterilization of juice that is to be sealed in tin cans. The cans may be filled with the hot juice, sealed immediately, preferably vacuum closed, and then be made to turn in order to sterilize thoroughly the inside of the can before being plunged into water for rapid cooling.

Description of the Flash Pasteurizer

Steam jacketed tubular heaters designed for rapid heating of liquids are manufactured by several concerns. The conducting tubes for the liquids may be made of stainless steel, block tin, aluminum or nickel. The liquids may be heated to high temperatures without scorching if a high velocity of flow is maintained. When the conducting tubes are flattened, the cross sectional area is reduced and the thin stream of liquid absorbs heat rapidly, thus reducing the time the liquid must be exposed to heat to raise the temperature to the desired point. Furthermore, the velocity and degree of agitation of the juice greatly affect the rate of heat absorption. For instance, Clement and Garland

(1) determined that water in feed water heaters moving at a rate of 17 feet per second absorbs heat three to three and one-half times more rapidly than that moving approximately one and one-half feet per second and 25 times more rapidly than water at rest.

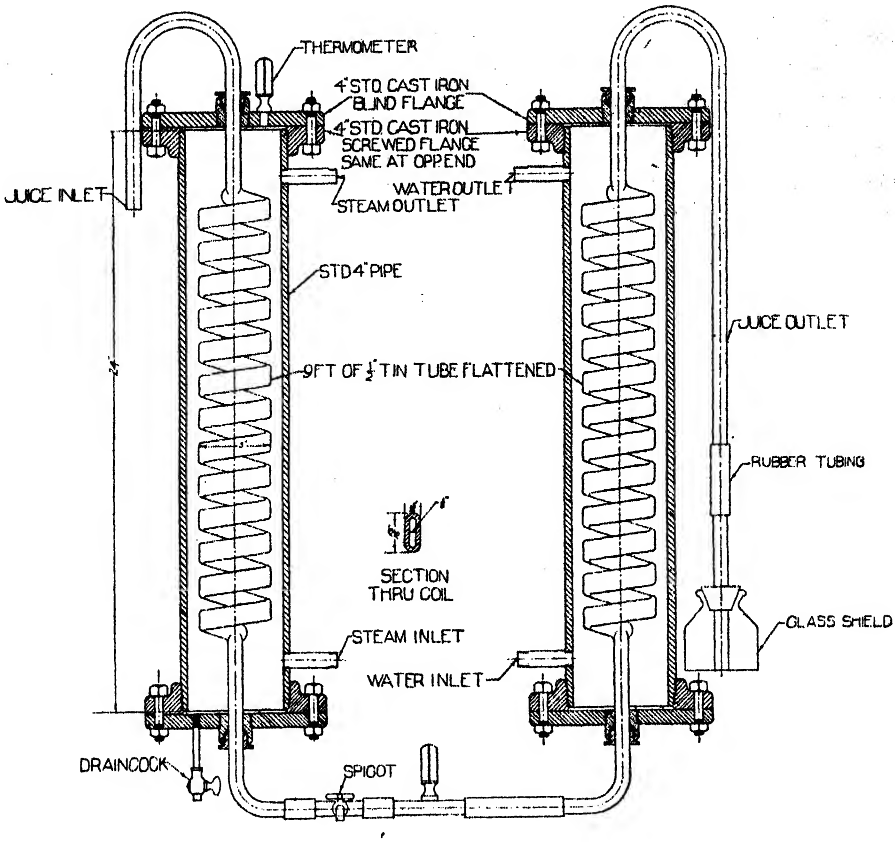
The flash heater used in these investigations is a modification of that described by Mottern and von Loesecke (4) which was found satisfactory for citrous juices. The middle 6 feet of a thin walled, block tin tube approximately 8 feet long was gradually flattened by running it through a tinsmith's roller several times until the opening was approximately 1/8 inch in width. The 6-foot section of flattened tubing was bent in serpentine fashion so that it could be jacketed in a 2½ inch iron pipe about 4½ feet long. The iron pipe jacket was capped at each end after providing for outlets for the block tin tube and packing nuts. Garden hose coupling fittings were installed near each end of the iron pipe for the introduction of and release of steam. A thermometer was also installed in the top cap of the iron pipe to permit reading temperatures of exit steam. A petcock was installed at the lower end of the steam jacket casing for release of water resulting from condensation.

A duplicate unit was constructed for rapid cooling of juice, subsequent to heating, when desired. The two units could be connected with rubber tubing when both were to be operated or either one could be used alone. A thermometer was installed in a T tube inserted in juice flow line between the two units to permit reading of temperatures of the juice as it left the heating unit. Thick-walled laboratory rubber tubing was fitted to the feed and exit ends of the block tin tubing.

During the first and second runs the cider was fed into the flash heater by gravity under a 2- to 3-foot head. Subsequently, the filter pump was used to deliver the juice under a pressure of two to four pounds. Gross regulation of rate of flow was governed by steam pressure and fine adjustment to maintain the desired temperature of the juice was controlled by a screw-type, laboratory pinchcock located near the discharge end of the rubber hose used for filling the bottles.

When the bottles are being filled with hot juice the direction of flow of the cider through the heater should be upward. If the juice is to be cooled before delivering to the bottles, thus necessitating a heating and a cooling unit, the juice should flow downward through the heating unit and upward through the cooling unit so as to exclude air in the system.

All the mechanical work involved in the construction of this flash pasteurizer was done by the writers. Some mistakes were made, and there is ample room for improvement in certain details. Another pasteurizer essentially as shown in the accompanying illustration is being constructed. The thin walled block tin tubing of the heater used the last season was flattened and shaped with considerable difficulty and by the time it had been rolled flat and shaped serpentine fashion several small holes had developed which had to be soldered. Furthermore, the tubing was not rigid enough to withstand the necessary handling in installation and subsequent use. Twenty-ounce tubing will be used in the construction of the next heater and the flattened tube will be coiled as shown in the illustration.



For large capacity commercial installations, the temperature of the juice may be controlled automatically by installing a thermostatically controlled steam regulator and a by-pass pipe and valve, the thermostat being installed in the juice flow tube near the exit of the heating unit.

Capacity of Flattened Tube Pasteurizers

The capacity of the pasteurizer used in these tests when operated with a steam jacket temperature of approximately 200° F. was approximately 25 to 30 gallons per hour. When higher rates of flow were attempted it was difficult to maintain a uniform maximum temperature for the juice. The 6-foot length of flattened tubing held approximately 6 ounces of juice. Therefore, at a rate of 25 gallons per hour, the average time the juice remained in the flattened portion of the tube was approximately 7 seconds.

The capacity of these pasteurizers may be increased by lengthening the flattened section of tubing enclosed in the steam chamber or by using tubing of larger diameter. Heid and Scott (3) report that a commercial block tin pasteurizer used for processing citrus juice by the Shary Products Co., Mission, Texas, has a capacity of 300 gallons per hour when the temperature of the juice was raised from 67 to

186° F., using steam at a pressure of 5 pounds per square inch. Twenty-six feet of 20-ounce tubing one inch in diameter was flattened to one-fourth inch and coiled in 14 turns. This was placed in a 4-foot, 2-inch length of 8-inch flanged pipe.

The accompanying tabulation is presented as a guide to prospective builders of coiled, flattened-tube pasteurizers of various capacities. The data are calculations based on the experiences of Heid and Scott and the writers, and are subject to revisions based on actual tests. It is assumed that the temperature of the juice is to be raised from 70 to 190° F. in approximately 8 seconds and that the mean temperature in the steam jacket is approximately 205° F. Any variations from these temperatures and the time the juice remains in the flattened section of the tubing will change the capacity accordingly. For instance, if the temperature of the juice can be raised to 190° F. in five seconds, the capacities would be fully 50 per cent greater than those indicated in the table. It must also be borne in mind that these data assume tubing that is flattened and coiled. The capacities of flattened tubing installed in a straight line rather than coiled or bent in serpentine fashion would be considerably less than indicated in this table. Also, the capacities for round or unflattened tubing would be substantially less than indicated.

Diameter of original tubing in inches	Flattened to (inches)	Cross-sectional area (square inches)	Length in steam chamber (feet)	Estimated capacity (gallons per hour)
1/2	3/32	.07	10	25
1/2	1/8	.09	8	25
1/2	5/32	.10	6	25
1/2	5/32	.10	12	50
3/4	1/8	.13	10	50
3/4	3/16	.19	7	50
3/4	3/16	.19	11	75
1	3/16	.27	10	100
1	1/4	.34	11	150
1	1/4	.34	16	200
1	1/4	.34	24	300
1-1/2	1/4	.54	16	300
1-1/2	1/4	.54	22	400

Summary

Apple juice clarified with Pectinol, filtered, heated to 190° F. in a flattened-tube pasteurizer for 7 to 10 seconds, bottled and immediately sealed, and stored at approximately 70° F. remained free of sedimentation, retained color, clarity and flavor, remained sterile, and had only a trace of an unobjectionable tendency toward a cooked or pasteurized taste.

Apple juice flash-heated in one unit of the flattened-tube pasteurizer and cooled in a second unit possessed a better quality than that bottled while still hot, but the juice of several bottles of some lots was recontaminated in the process of bottling which resulted in subsequent development of mold mycelia.

A description of the flash pasteurizer used in the experiments is presented and directions are provided for the construction of coiled, flattened-tube pasteurizers of various capacities.

Literature Cited

1. Clement, J. K. and Garland, C. M. The Transmission of Heat to Water in Tubes as Affected by the Velocity of the Water. Univ. of Ill. Eng. Exp. Sta. Bul. 40. 1909.
2. Fabian, F. W. and Marshall, Roy E. How to Make, Clarify and Preserve Cider. Mich. Agr. Exp. Sta. Circ. Bul. 98 (revised). 1935.
3. Heid, J. L. and Scott, W. C. The Capacity of Flattened-tube Juice Pasteurizers. Fruit Prod. Jour., 16 (5): 136-139. 1937.
4. Mottern, H. H. and von Loesecke, H. W. De-aeration and Flash Pasteurization of Orange and Grapefruit Juices. Fruit Prod. Jour., 12 (11): 325-326. 1933.

THE RELATION OF WASHING OPERATIONS TO BRUISING AND KEEPING QUALITY OF McINTOSH AND NORTHERN SPY APPLES

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Some wholesale buyers of apples in Michigan have shown a decided preference for unwashed fruits, claiming that washed apples do not keep satisfactorily in cold storage. Inasmuch as this prejudice on the part of several dealers against washed apples has persisted for several years, it seemed advisable to determine if such claims are justified, and if so, to ascertain the reasons for any differences in keeping quality.

During the fall of 1936 arrangements were made with several grower-packers and fruit handling organizations to permit the writer to obtain one bushel of apples of the McIntosh and Northern Spy varieties at each of the following stages in the handling operations: (1) upon delivery to the packing house and before washing, (2) after having passed through the washing machine, (3) after washing, grading, sizing, and packing.

The apples selected at the handling stages designated as Nos. 1 and 2 were essentially the same in respect to sizes and grades as those being packed except that in most cases they represented the average in respect to bruises and skin punctures. The apples collected before and after washing were ring-faced and packed in bushel baskets or gift boxes, the same packing devices being used that were employed by the regular packing crews in each of the houses except that each apple was laid in position by hand and efforts were made to reduce any further bruising to a minimum.

Except as noted later, those baskets or boxes of apples were then carefully transported varying distances by passenger automobile or light truck to East Lansing where they were placed in cold storage.

Bruises and Handling Operations

Gaston (2) found that 30 per cent of the Michigan B-grade and 20 per cent of the cull Northern Spy apples at one western Michigan packing plant in 1924 and 1925 were placed in these grades because of handling bruises. The percentages for McIntosh were approximately 20 and 27 per cent, respectively, for B grade and culls. Those data were obtained before the introduction of washing operations and the study was made in a packing plant that has a reputation for rather careful handling of apples.

Overholser (3) made a study of bruising occurring in handling operations in western New York in 1935 and reports that 26 per cent of the McIntosh apples included in the investigation showed minor bruises (less than one-fourth inch in diameter) and 40 per cent showed major bruises (one-fourth inch or more in diameter) as a result of harvesting operations, and that only 4 per cent of the Winter Banana apples included in the study were free of bruises at the end of the cold storage period.

Ellenwood (1), working in Ohio in 1936, found 36 per cent of the McIntosh apples had accumulated five or more bruises per apple by the time they had reached the feed table of the washer. Those percentages were increased to 50 by the time the apples had passed through the washing machine and to 65 after having passed over the sizing machine. The sizing machine caused more bruises than any other handling equipment or practice. He also found that fruit handled by three carefully instructed pickers accumulated 209, 250, and 283 bruises per 100 McIntosh apples in harvesting operations.

For the study herein reported, the first examination for bruises was made after the apples had been delivered to the packing house, transferred from the field containers to bushel basket or eastern or gift box by hand and then transported from western Michigan to East Lansing. Consequently, the number of bruises reported both before and after washing are greater than would have been found had the examinations of the apples been made in the various packing houses. However, the differences reported herein for numbers of bruises before and after washing should be essentially the same as would have been found had the counts been made in the packing houses.

Any depressions felt in passing the tips of the fingers over the surfaces of the apples are designated as minor bruises in the tabulations presented. Subsequent paring of the fruits, however, indicated that this method detected only approximately 40 to 50 per cent of the actual bruised areas of the fruits. Bruises some five-eighths inch or more in diameter with conspicuous indentations and having more or less of a water-soaked appearance are designated as major bruises. Any breaks through the skin of the apple, whether in the nature of stem punctures, mechanical cuts, or growth cracks, are listed as skin breaks.

Packing House Equipment and Methods of Handling

Both the McIntosh and the Northern Spy apples handled through packing house A were picked into 20-quart galvanized iron pails which were transported to the packing house on a truck, where the pails of

apples were emptied onto the feed table of the washer by placing a large, square board over the top of the pail, inverting the pail on the table and pulling out the board. Overholser (3) found such picking utensils to result in much less bruising of fruits than rigid metal, felt padded containers with drop bottom canvas transfer aprons or canvas picking bags. Furthermore, the practice eliminated the usual emptying from picking container to orchard crate which Ellenwood (1) reports resulted in more than 3 per cent of the final bruises. The apples were washed in a flotation type machine which is well-padded with sponge rubber in places where apples drop or roll onto boards. The washing solution was one per cent hydrochloric acid. The apples passed from the rinse section of the washer to the Cutler sizer. The packing house crew did not permit apples to accumulate or pile up in the bins. Much care was exercised throughout the handling operations to reduce bruising of tender varieties to a minimum.

The McIntosh handled in packing house B consisted of lots from three growers (three bushels each), but all of the Northern Spy were grown by one orchardist. The washer consists of a belt dump section, a shuffle board feed section, a rotating underbrush, overhead flood type wash section, a shuffle board rinse section, and a step-over dryer. A one per cent hydrochloric acid washing solution was maintained, to which 5 pounds of salt was added per 100 gallons of solution.

The apples were "poured" onto the belt dump section much faster than the rated capacity of the machine, resulting in considerable "double decking" of apples in the washer. The rate of washing and grading at the time the Northern Spy samples were taken was 265 bushels per hour. The apples passed from the drying section to the sorting and then to the sizing sections of a Niagara grader and were distributed to large packing bins by belts. The unwashed Northern Spy samples were picked from the feed section of the washer and an attempt was made to select specimens of uniform size that were relatively free from conspicuous bruises. A similar practice was followed at the conveyor section between washer and sizer. The McIntosh samples from this house may be regarded as orchard run in respect to numbers of bruises and therefore, may be compared with those from other packing houses.

Two complete washing machines in tandem were operated in packing house C. Both machines employed the over-head flood and the apples were propelled forward through feed, wash, rinse, and drying sections by the step-over method. Hydrochloric acid at a concentration of one and one-half per cent was employed in both machines. The apples were washed at the rate of about 150 bushels per hour. From the second drying section the apples were conveyed onto the sorting section of a Cutler, gravity type, sizing machine. The apples were lifted by hand from the packing bins into the packing containers, though some packers were allowing the apples to drop a few inches.

The apples for packing house D were transported about 70 miles from orchard to packing house in slatted crates. They were washed with a one and one-half per cent solution of hydrochloric acid, and then rinsed through a rotating underbrush, overhead flood machine. The dryer section consists of moisture-absorbing rollers. At the time the McIntosh were washed the machine was not padded except for

canvas placed on the floors of the feed and outlet bin sections. Furthermore, the apples dropped about five inches from the last drying roller to the floor of the outlet bin. Prior to the time the Northern Spy were washed the feed section, including the shuffle board feed, and the outlet bins, were padded with sponge rubber and the drop from the drying rollers eliminated. The washer and grader are not connected, thus necessitating an additional filling of slatted crates from the washer and a dumping of crates of apples onto the grader. The grader is a Cutler of the gravity type.

Six bushels of Northern Spy apples were carefully selected for uniformity in size and color and for practical freedom from bruises for the test in packing house D. Two of the six bushels were stored immediately, four were fed by hand onto the feed section of the washer, and two of these bushels placed in storage after washing, and two of the four washed bushels were run over the sizing machine and placed in packing forms by hand for transference to bushel baskets before storage. This particular test was designed to show the extent of bruise accumulation in a rotating underbrush washer when rough handling at the feed and outlet ends of the machine is reduced to a minimum.

The Northern Spy apples for packing house E were smaller, greener and possessed less red color than apples of this variety from other houses. The washer is an over-head floor, shuffle board type. The apples move from a drying section, similar to that described for packing house B to a small sizing machine equipped to provide three sizes of apples. A series of rubber belts with perforations for the respective size grades is the principle employed. All apples are packed in eastern boxes lined along the side walls with cardboard and with shredded paper pads placed on both top and bottom of pack.

Bruises Accumulated During Washing Operations

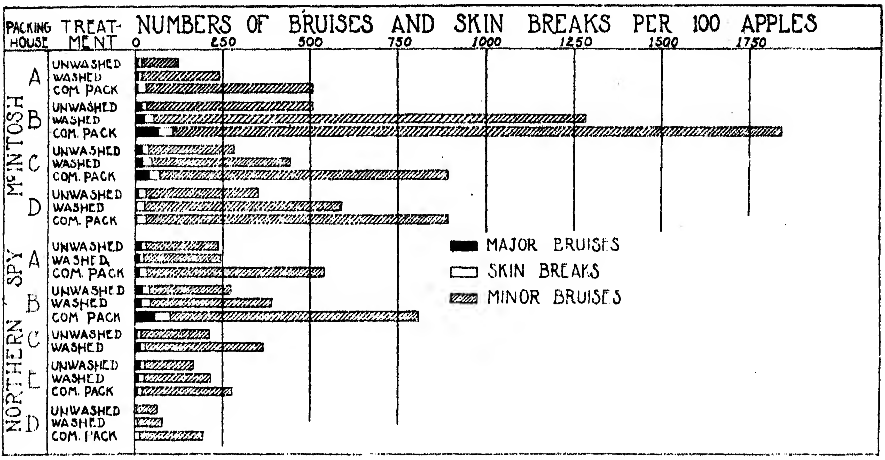
The figures of the column headed "Tree to packing house" in Table 1 and the lots designated "Unwashed" in Fig. 1 (different designations for the same lots) show substantial differences in the numbers of

Table 1. Bruises accumulated on McIntosh and Northern Spy apples.

Variety	Packing house	Bushel Nos.	Pressure test (pared)	No. apples per packed bushel	Total bruises per 100 apples accumulated in—		
					1	2	3
					Tree to packing house	Washing operations	Grading and packing *
			(pounds)				
McIntosh......	A.........	1 to 3	10.6	125	111	120	252
	B.........	7 to 15	12.1	135	490	616	787
	C.........	16 to 21	12.0	142	272	142	586
	D.........	22 to 24	12.8	150	327	238	297
Northern Spy..	A.........	25 to 27	15.7	88	225	4	287
	B.........	35 to 40	17.1	116	254	212	409
	C.........	28 to 31	14.0	99	199	160	—
	**D.........	41 to 46	18.5	123	59	11	109

*The figures for "tree to packing house" include packing in baskets or eastern boxes for transport to East Lansing. The figures in this column and the next are therefore higher than would be the case had they been examined without packing.

**Apples selected were practically free from bruises before subjected to treatments.



bruises accumulated in harvesting operations and delivering the apples to the packing house. The McIntosh apples picked into the 20-quart galvanized iron pails (packing house A) and delivered to the feed table of the washer in those pails had far less bruises than other lots presumably picked into various other kinds of utensils and emptied into slatted crates for delivery to the packing houses. The Northern Spy apples handled similarly had a few more bruises than those handled through packing houses C and E, but the writer is skeptical as to whether he succeeded in obtaining a truly representative sample for this lot in view of the fact that washing operations seemed to add only four additional bruises per 100 fruits. Several of the lots of McIntosh had obviously been subjected to careless handling. One of the three growers' lots of McIntosh that make up the average for packing house B showed an average of more than six bruises per apple upon delivery to the packing plant and this lot was in far better condition than the average grower lots delivered to this house on the day of sampling.

At the time the plans were made for this study it was expected that the data would provide some information relative to the amount of bruising resulting in various types of washing equipment. The flotation washer caused fewer bruises than any other type of machine included in the study, but the writer is of the opinion that the management in this packing house would operate any of the other machines with substantially fewer bruises than are reported in the tabulation. In other words, any potential differences in equipment are masked by the personal factor. The great accumulation of bruises in packing house B resulted from "pouring" of apples from the field crate onto the feed belt and from forcing the equipment to handle apples considerably in excess of the rated capacity rather than from kind of equipment employed.

It appears that the personal factor is one of greatest importance in respect to accumulation of bruises in washing operations. The factor of next importance is probably that of adjustment and padding of equipment. Sponge rubber should be used freely where apples are

likely to drop onto or roll against boards such as those used in the shuffleboard arrangement. Any places where apples may drop more than an inch onto other fruits or onto boards should be adjusted. Such adjustments and sponge rubber applications were made for the washer in packing house D between the washing of the McIntosh and Northern Spy and the amount of bruising was reduced substantially.

Table 1 shows that washing operations added from 120 to 616 bruises per 100 McIntosh apples in the packing houses included in this study. Seventeen to forty-two per cent of the bruises on McIntosh apples in the commercial packed baskets or boxes were due to washing operations. Northern Spy apples were washed in the same plants, with the same crews and machines, with substantially less bruising than that observed on McIntosh. Also, washing accounted for smaller proportions of the final numbers of bruises on Northern Spy than on McIntosh.

Though the numbers of bruises on these varieties attributable to washing operations appear to be high in several cases, washing produced fewer bruises in most instances than either pre-packing house handling or sizing, grading, and packing. On the whole, sizing, grading and packing operations accounted for the greatest numbers of bruises. Ellenwood (1), working in Ohio, found that the sizing machines caused more bruising of apples than any other piece of equipment.

On the whole, the data show that each successive handling from tree to packed containers causes more or less additional bruising of the apples. If it were possible to eliminate one or more operations, the amount of final bruising would likely be reduced accordingly. Furthermore, careful handling to reduce bruises in any one operation results in less bruises on the final packed product. Rough handling in some packing house operation probably adds just as many bruises to apples that are already badly bruised as it does to apples relatively free from bruises. Therefore, the number of bruises on apples in the packed container depends on the handling practices of the grower as well as those of the packing house.

Washing is to be regarded as one more handling practice and washed apples, therefore, may be expected to show more bruises than unwashed ones. The washing equipment, however, does not account for as much bruising in most cases as either pre-washing or post-washing operations in preparing the apples for shipment in closed containers.

Storage Tests

Three pressure test readings were made on each of 10 representative, pared apples of each bushel at the time they were examined for bruises, October 24 to November 4, inclusive. The apples were then returned to cold storage where the McIntosh remained for approximately 10 weeks and the Northern Spy for 19 weeks. At the end of these respective storage periods, pressure tests were repeated for each lot to determine the rates of softening or ripening.

On the whole, there were no consistent differences in rates of softening for the differential handling treatments. Differences in rates of softening for individual bushels grown in the same orchard and subjected to identical handling practices were as great as differences be-

tween treatments. The average rates of softening for washed and unwashed apples of each of the two varieties under observation were essentially the same. Furthermore, no relationship was found between numbers of handling bruises and subsequent rates of softening in storage.

Weight losses were determined for each lot of McIntosh and Northern Spy apples during their storage periods of 10 and 19 weeks, respectively, to ascertain whether washing operations affected rates of moisture loss. The mean temperature of the storage room was approximately 34 degrees though the temperatures ranged from 30 to perhaps 40 degrees. The relative humidity ranged from 70 to 80 per cent during a greater portion of the storage periods. These conditions of storage were purposely not ideal and were designed to accentuate any potential differences in susceptibility to losses of moisture.

The average weight loss for the McIntosh apples in 10 weeks was 2.6 per cent. The various lots ranged from 1.3 to 3.9 per cent loss in weight. Thus, the weight losses were not great enough to produce any possible consistent differences due to different handling treatments. In only two of the seven possible comparisons did the washed apples show greater weight losses in storage than unwashed apples. On the other hand, if all unwashed lots are averaged together, the weight loss amounts to 2.2 per cent while that for the washed McIntosh is 2.7 per cent and that for washed, mechanically sized and packed apples is 3.0 per cent.

The average weight loss for the unwashed Northern Spy apples stored in closed containers during the 19 weeks storage was 5.3 per cent compared with a loss of 6.0 per cent for the washed apples. Two bushels subjected to each treatment were stored in open crates and the weight losses were 8.1 and 8.0 per cent, respectively, for unwashed and washed apples. Such differences as were found are rather inconsistent and not great enough to be regarded as significant.

At the conclusion of the storage period for each variety, 10 representative apples of each lot were weighed and placed on an office table for 10 days to determine rates of weight losses at an approximately mean temperature of 70 degrees and a mean relative humidity of 27 per cent in the case of McIntosh and approximately 22 per cent for the Northern Spy. The average weight loss for the unwashed McIntosh samples was 2.63 per cent while that for the washed samples of this variety was 2.64 per cent in 10 days. The average weight loss for the unwashed Northern Spy apples was 3.95 per cent in 10 days and that for washed apples was 3.88 per cent.

The rates of weight losses for both varieties at living room temperature and humidity at the times of the determinations were essentially the same for washed and unwashed apples. These apples, however, had been in cold storage for 10 and 19 weeks and during this storage period natural wax accumulation may have been sufficient to have eliminated any possible differences that may have been existent immediately after washing.

Decay and Breakdown in Storage

The amounts of decay developing during cold storage of the various grower lots of McIntosh and Northern Spy were too inconsistent to

provide any significant differences between washed and unwashed apples. In some cases the unwashed developed more decay than washed fruits, in other cases the opposite was true, and in still other cases there were no differences. If all lots of unwashed McIntosh are averaged, the percentage of decay is 6.1 compared with 7.0 per cent for washed apples and 6.9 per cent for washed, sized and packed lots. Similarly, 6.2 per cent of the unwashed Northern Spy apples developed decay in storage compared with 5.1 per cent for the washed lots. A comparable average calculation for the washed, graded and packed Northern Spy is not possible because such lots were not available for one packing house.

Such decay as was found began development at stem punctures and at other skin breaks. No relationship was found between size of individual apples and development of decay.

The amount of flesh or physiological breakdown developing during the cold storage period for the Northern Spy lots under observation varied considerably with grower lots, but no consistent differences were found for washed and unwashed lots. The observer noted that the specimens showing physiological decay were the larger ones. Unfortunately, the specimens were not weighed individually. The accompanying table, however, gives the average weight of the apples at the beginning of the storage period, the percentage of fruits discarded at the end of the storage period because of breakdown, and the pressure tests. There appears to be no close relationship between percentage of specimens showing breakdown at the end of the storage period and stage of maturity when harvested as indicated by the pressure tests, but there does appear to be a significant relationship between average size of apples and susceptibility to breakdown. Nearly one-fourth of the apples averaging one-half pound in size were discarded at the end of the storage period because of breakdown (these lots were plus 3 inches in diameter), while apples averaging about one-third pound in size developed none of this trouble.

Table 2. The relation of average size of Northern Spy apples to percentage of physiological breakdown during a storage period of 19 weeks.

Source of apples	Average pressure test at packing time	Average weight per apple in pounds	Percentage of specimens showing physiological decay
	(pounds)		
A	15.7	.50	24
B, Grower No. 1	17.4	.42	10
C	14.0	.44	3
D	18.5	.35	1
B, Grower No. 2	16.7	.34	0
E	17.8	.30	0

On the basis of the general information afforded in this study, it appears that Northern Spy apples attaining sizes larger than three and one-fourth inches in 1936 were very subject to the development of physiological breakdown or decay when held for four or five months in cold storage, and that specimens less than three inches in diameter

were free from such a disorder when stored under similar conditions. To what extent apples from three to three and one-fourth inches in diameter may have been subject to the trouble under these conditions is questionable.

Conclusions and Summary

This study was based on 24 bushels of McIntosh grown in seven orchards and handled through four packing houses and on 22 bushels of Northern Spy grown in five orchards and handled through five packing houses. Except for one duplicate set of Northern Spy bushels, one-third of the bushels were not washed, one-third were washed, and another third were washed, graded, mechanically sized and packed.

Any handling practice adds to the final number of bruises on tender varieties of apples. Therefore, washed apples are bound to show more bruises than unwashed apples.

Washing operations accounted for an average of 25 to 30 per cent of the final bruises found on commercially packed McIntosh apples and an average of 10 to 12 per cent of the bruises found on commercially packed Northern Spy.

In general, both pre-washing and post-washing operations caused more bruises on both McIntosh and Northern Spy apples than washing practices.

The amount of bruising probably varies with type of washing equipment employed, but in these studies any such differences were masked by the personal factor or the packing house management.

The number of bruises accumulated in washing, as well as in any other handling practice, may be held at a low figure if the equipment is adjusted properly, if it is well-padded with sponge rubber where apples drop onto or against lumber, if the machine is not operated above rated capacity, and perhaps most important, if the apples are handled carefully at the feed end of the washing machines.

Washing practices did not affect the rate of softening, rate of decay or rate of shriveling or moisture loss in storage, nor did they affect the rate of moisture loss of apples that had completed the usual cold storage period and were subsequently removed to conditions of high temperature and low humidity.

More or less incidental to the planned investigation, it was found that large Northern Spy apples (3½ inches in diameter) of the 1936 crop were susceptible to physiological breakdown or decay while apples of medium size (less than 3 ins. in diameter) were resistant to this trouble.

In general, unwashed apples excelled washed apples only in respect to numbers of bruises and skin breaks.

Literature Cited

1. Ellenwood, C. W. Origin of handling bruises in harvesting apples. 1936. Proc. Ohio State Hort. Soc. 17: 36-44. 1937.
2. Gaston, H. P. Why a cull apple is a cull. Mich. Agr. Exp. Sta. Spec. Bul. 160. 1927.
3. Overholser, E. L. Bruising in harvesting and handling apples and its relation to spray residue removal. Proc. N. Y. State Hort. Soc. 81: 51-62. 1936.

BULLETIN REVIEWS

Circular Bulletin 160.—Protecting Cherries from Birds.—Cardinell, H. A.—Data are presented on the extent to which birds, notably robins and starlings, cause losses in cherry and other fruit plantations. A device that frightens birds away by means of regularly-timed explosions is described, together with the results of experimental tests in a number of cherry orchards. (22 pp., 4 tables, 7 figs.)

Circular Bulletin 161.—Soybean Production in Michigan.—Megee, C. R.—This bulletin deals with the use of soybeans on the farm and in industry and commerce as well as those cultural practices followed in producing the crop. Soybeans are used on the farm as an emergency hay crop, as a supplementary protein feed, for silage, as a cash crop, and as a soil improving crop. Their adaptation is limited largely to those sections where corn can be grown as a grain crop. Under cultural practices such topics as varieties, time, rate, and method of planting, inoculation, cultivation and harvesting are discussed. A list of industrial and commercial uses of soybeans is given and a brief statement made concerning soybeans for human food. (14 pp., 4 tables, 3 figs.)

Circular Bulletin 162.—Soil Erosion in Michigan Orchards.—Partridge, N. L.—Information is presented on the extent to which soil erosion takes place in Michigan orchards, its influence on tree growth and productivity. Practical methods for preventing erosion are discussed. (35 pp., 24 figs.)

Special Bulletin 283.—Some Characteristics of Rural Families in Three Michigan Communities.—Hoffer, C. R.—This publication contains information about certain characteristics of 741 rural families in three well-established agricultural communities. An adverse relationship was clearly evident between the presence of housing facilities and large families. All of the families had houses which were ample in size, but in a large proportion modern conveniences were absent. Only about one-fourth of the husbands and one-third of the wives had attended high school. However, there were no significant relationships between the educational status of parents, as indicated by grades reached in school, and the progress of their children in school. Three-fifths of those families had membership in a church and one-half were represented in fraternal organizations. The number having membership in other more specialized organizations was not so high, but in general this aspect of family life was encouraging. Only about 10 per cent of the total families were without the benefits of membership in any organization. The relationships of children to organizations was similar to that of their parents. The way in which the young people spent their leisure time while at home was similar to that of adults. Reading and listening to the radio were the principal forms of leisure for both young people and adults.

Special Bulletin 284.—Economic Aspects of Lamb Feeding in Michigan.—Wright, K. T.—Results are presented of a survey conducted during the years 1931-'35. It was found that on the average during that period lambs returned the feeders $1.40 for every dollar spent for feed, though net returns per lamb ranged from as low as $0.05 in 1934-'35 to a high of $1.79 in 1933-'34. Four factors were found to be of major importance in determining the net returns from lamb feeding: (1) the feeding ability of the farmer, (2) the margin between purchase and sale price of the lambs, (3) the daily gains made by the lambs, and (4) death losses. (24 pp., 13 tables, 5 figs.)

Special Bulletin 285.—The Reaction of Greenhouse Plants to Gas in the Atmosphere and Soil.—Krone, P. R.—Minute quantities of gas escaping into the atmosphere cause injuries of different kinds to plants. Most common types of injury are (1) a peculiar drooping of leaves called epinasty, (2) defoliation, and (3) leaf yellowing. The best method of diagnosis in case of suspected gas injury is to expose some very sensitive test plant, such as the tomato, for a few hours in the greenhouse in question. Symptoms of gas injury on a large number of the more common greenhouse plants are described and illustrated and methods suggested for dealing with the trouble. (35 pp., 32 figs.)

Special Bulletin 286.—Cost of Producing Apples in Berrien County, Michigan. 1935.—Wright, K. T. and O'Brien W. R.—Average production costs on an acre basis were found to be: cultural practices, $36.13; harvesting, packing, and marketing, $37.37; overhead, $31.13; total, $104.63. On a bushel basis they were: cultural practices, $0.196; harvesting and marketing, $0.203; overhead, $0.170; total, $0.569. Profitable production was found to be associated with the better varieties, good sites and soils and good cultural practices and with relatively high yields. (35 pp., 22 tables, 6 figs.)

Technical Bulletin 154.—The Toxicity of Combinations of Nicotine, Under Michigan Conditions, to the Tree and to the Codling Moth.—Merritt, J. M.—Three series of nicotine combinations were tested for codling moth control.

The first, containing the soluble and non-volatile material Nico-Zin, required the addition of oil (in less than ovicidal concentration) to effect excellent control of deep and shallow codling moth injury. The addition of oil resulted in decrease in color and increase in rate of dropping. The material has great promise, if an innocuous spreader can be developed.

The second series, combining nicotine sulphate (Black Leaf 40) with summer oil emulsions, gave excellent control of codling moth injury. No reduction in color, but an increase in rate of dropping, was observed. The nicotine deposit on this series was so low as to indicate considerable ovicidal effect from the concentration of summer oil used. Some injury to the fruit resulted from any schedule using oil in all cover sprays, and was accompanied by a reduction in photosynthetic activity of the leaves.

The third series, bentonite-nicotine combinations (B. L. 155) gave somewhat poorer control, but in no way injured the fruit or foliage of the tree.

It has been shown that it is possible to modify the nicotine volatilization by certain combinations, and that the deposition of nicotine by each spray is proportional to the control of codling moth, except when materials used in modification are in themselves insecticides.

Lead arsenate was used as the standard of comparison, and gave excellent control of deep entries, but the high proportion of stings is undesirable in the production of high quality fruit, even though the death of the worm results. (47 pp., 23 tables, 9 figs.)

Technical Bulletin 155.—The Fusarium Yellows Disease of Celery (*Apium graveolens* L. var. *dulce* D. C.)—Nelson, R., Coons, G. H., and Cochran, L. C.—Symptomatic aspects of three distinct forms of the disease are described in detail. Two forms are of widespread occurrence, but the third has been observed only in one locality in California. Formal proof is submitted of the etiological relationship of Fusaria to the yellows disease. In the classification of the yellows pathogens difficulties inherent in the system usually employed were encountered and a critical discussion is included of the present concepts of taxonomic criteria. It is proposed that, in addition to morphology, the host relationship be stressed as a taxonomic character of value in classifying the wilt-producing species of Fusarium.

Methods were developed for differentiating the pathogens that cause form I and form II of yellows. Color reactions on rice, responses to copper salts in the culture medium and symptoms induced in the host plants were used for typing unclassified isolates. Each isolate tested produced a single form of the disease and retained its pathogenic and physiologic integrity after repeated passage through susceptible varieties of celery. The host relationship was used as the chief basis for assigning the form I pathogen to a new species, *Fusarium apii* n. sp. and the form II fungus is made a variety of it, *Fusarium apii* var. *pallidum* n. var.

The influence of controlled environmental factors on the growth of celery and on the development of the disease were studied and the results obtained confirmed field observations on the relation of soil temperature and soil moisture to the seasonal incidence of yellows. In experiments on the control of the disease, field results proved that the pathogens could be eradicated by steaming infested soil, but this method is impractical except in seed beds or where the area of infestation is small. Chemical treatments of soil were ineffective. By breeding for resistance Fusarium yellows has been effectively controlled in the highly susceptible Golden Self-Blanching types of celery. The green types are somewhat resistant but most commercial varieties do not withstand the disease well in hot and dry seasons. Desirable types of yellow and green celery have been produced by breeding and results are given of field trials for resistance and adaptability of these new celeries in comparison with leading commercial varieties. (74 pages, 17 tables, 18 plates.)

Memoir 2.—Studies of Osteology and Myology of the Beaver.—Young, F. W.—A detailed description of the skeletal and muscular structures of the beaver. (84 pp., 24 plates.)

JOURNAL ARTICLE ABSTRACTS

Clinical Results in the Treatment of So-called Functional Sterility of Cows.—Clark, C. F.—Jour. Am. Vet. Med. Assoc. XC N. S. 43 (4): 488-492. 1937. Journal Article No. 109 (N. S.) from the Michigan Agricultural Experiment Station.—In reviewing data on the treatment of 442 cases of female bovine sterility, 73 cases were recorded which presented no recognizable abnormalities. Methods of treatment were adopted that were believed to favor conception. Treatment consisted of douches of normal salt solution, ovarian massage or the use of ovarian extracts.

Group I consisted of 41 cows and heifers served a total 192 times (ave. 4.6) without conception. Using uterine and/or vaginal dôuches of normal salt solution at the time of heat, before breeding, 38 conceived. A total of 81 services were necessary (ave. 1.9).

Group II was composed of 15 cows and heifers without recognizable pathology, except quiescent ovaries were observed. Treatment by massage of ovaries was given and following such treatment 14 conceived. A total of 27 services were required (ave. 1.9).

Group III, 17 cows and heifers bred a total of 78 times (ave. 4.5) were treated with ovarian extracts in an attempt to intensify the phenomenon of heat. Ten head so treated conceived after being bred a total of 16 times (ave. 1.6).

Of the remaining seven in the group, six later conceived, but at such time as to preclude beneficial effect of the extract used.

There was no conclusive evidence that a nutritional factor was involved which grazing animals received and stabled animals did not. No Vitamin E therapy was used.

Streptococcic Infections in Dogs. I. "Acid Milk," Arthritis and Post-Vaccination Abscesses.—Stafseth, H. J., Thompson, W. W. and Lisa Neu.—J. Am. Vet. Med. Assoc. 43 N. S. (6): 769-780. 1937. (Journal Article No. 147 (N. S.) from the Michigan Agricultural Experiment Station.)—Judging by the older literature dogs are only slightly susceptible to streptococcic infections. The streptococci found in dogs are not identical with human and equine strains, as suggested by Holman. According to the authors' findings, so-called "Acid Milk" in young pups may be a streptococcus infection contracted from the mother or perhaps contaminated quarters. If this should prove to be the case, sanitary measures and possibly immunizing treatments may prove to be the solution to this malady rather than dietary adjustments. It is not impossible that deficient diets might constitute predisposing causes. Two dogs suffering from arthritis and muscular rheumatism were treated successfully with autogenous bacterial vaccines made of streptococci (in one case streptococci and colon bacilli). Streptococci were also isolated from abscesses resulting from antirabies vaccination. Since streptococci were not found in a sample of vaccine examined, it may be possible that the infection was caused by organisms carried on the

skin of the animal. For this reason it seems advisable to use greater aseptic precautions than are ordinarily employed in injections of vaccines.

Some Physico-Chemical Relationships Found in Four Erosive Soils of the Piedmont Plateau Region.—Rogers, H. T.—Jour. Amer. Soc. Agron. 29 (1): 1-9. 1937. (Journal Article No. 182 (n. s.) from the Michigan Agricultural Experiment Station.)—A technical article containing the results of a laboratory study of four highly erosive soil types found on the Piedmont Plateau. The object of the study was to determine possible correlations between some physical and chemical properties of the soils and their susceptibility to erosion. The soil samples used in the investigation were taken from the following soil types: Iredell loam, White Store fine sandy loam, Helena fine sandy loam, and Orange silt loam. The silica-sesquioxide molecular ratios, hygroscopic water, maximum water-holding capacity, moisture equivalent, mechanical analysis, aggregate analysis, exchangeable hydrogen, base exchange capacity, and the soil reaction values were determined on the soil samples.

Significant correlations were found with hygroscopic water and base exchange capacity, percentage base saturation and soil reaction values, and hygroscopic water, maximum water-holding capacity, and moisture equivalent. The surface soils are characterized by a low degree of base saturation and water-holding capacity.

Effect of Light Intensity on the Photosynthetic Efficiency of Tomato Plants.—Porter, A. M.—Plant Physiology. 12: 225-252. 1937. (Journal Article No. 188 from the Michigan Agricultural Experiment Station)—With decreased light intensity there was found to be: (a) greater vegetative growth, as measured by leaf area, and both fresh and dry weight of tops and roots, (b) decreased fruit production, and (c) a decrease in the total amount of photosynthate produced by the plants. However, the increase in vegetative growth and the decreases in fruit production and total photosynthate produced were not directly proportioned to decreases in light intensity. Partially shaded leaves used their limited light supply more efficiently than unshaded leaves used their normal supply.

Great as were the differences between the growth rates, leaf areas, and fruit and photosynthate production of the several groups of plants exposed to the different light intensities, there were equally great differences between different plants within the same group in their apparent ability to utilize their light supply for fruit and photosynthate production. This suggests the possibility of developing strains of plants having a high degree of photosynthetic efficiency for culture under conditions of low light intensity.

The Use of Colloidal Iodine as a Modification of the Gram Stain.—Lyons, D. C.—Jour. Lab. and Clinical Med. 22 (5): 523-524. 1937. (Journal Article No. 201 from the Michigan Agricultural Experiment Station.)—Gram's modification of Lugol's solution consisting of sublimed iodine (1 gm.), potassium iodide (2 gm.), and distilled water (300 c.c.) does not have sufficient penetrating power completely to fix the cell walls of many types of micro-organisms. It has been found that a one per cent suspension of colloidal iodine, when substituted

for the usual Gram's iodine solution in the routine of this staining procedure results in a number of Spirochaetaceae taking a much deeper and clearer stain.

An Improved Technic for Metabolism Studies in Pre-School Children with a Statistical Determination of Its Reliability.—Hawks, J. E., Dye, M., and Bray, M. M.—Jour. Nutrition. 13 (1): 51-64. 1937. (Journal Article No. 263 (n. s.) from the Michigan Agricultural Experiment Station.)—The composition of diets containing the same food and prepared under standard conditions varied not only from period to period but also between duplicate diets collected on the same day. Nevertheless, the coefficients of variation for calories, calcium and phosphorus were not large, ranging between 1.6 and 3.1. Refinements in technic to reduce error are described.

On Mounting Micro-Diptera.—Sabrosky, C. W.—Ent. News. 48; 102-107. 1937. (Journal Article No. 268 (n. s.) from the Michigan Agricultural Experiment Station.)—The advantages and disadvantages of four methods of mounting minute Diptera (flies) are discussed in connection with detailed instructions for making the type of mount which is believed to offer the most advantages and the least objections of any of the methods.

Effect of Diet on the Constancy of the Urinary Nitrogenous Constituents Excreted Daily by Pre-School Children.—Hawks, J. E., Bray, M. M. and Dye, M.—Jour. Nutrition. 13 (2): 179-192. 1937. (Journal Article No. 270 (n. s.) from the Michigan Agricultural Experiment Station.)—The amount of total urinary nitrogen, urea, creatine and, in one experiment, uric acid excreted by six children on constant medium protein diets following a 10- or 12-day preliminary period varied to approximately the same degree as the values for diet nitrogen. Uric acid in one experiment and creatine in both were about twice as variable as diet nitrogen, while ammonia, acidity and amino acid showed more irregularity. The increase in the protein content of the diet caused the values for total nitrogen, urea, ammonia and creatine to be more variable, especially during the first 9 days. Then the figures reached an equilibrium similar to that on the first diet. The change in diet did not seem to influence the variability of the data for acidity, uric acid, amino acid or creatine. Individual children tended to react in a similar manner both to the constant diet and to the change in the protein content of the diet.

Location of the Line of Union in a Cleft Graft.—Bradford, F. C.—Proc. Am. Soc. Hort. Sci. 34: 295. 1936. (Journal Article No. 273 (n. s.) from the Michigan Agricultural Experiment Station.)—An illustration is given of callus tissue from the stock growing a couple of inches above the point where the stock was cut off. Branches arising from this stock tissue, though *apparently* springing from above the point of union of stock and at first suggesting an influence of stock on cion, in reality are of stock tissue only. It is suggested that a number of instances of this kind have been mistakenly cited as illustrations of rather marked effects of stock on cion.

The Relation of Degree of Finish in Cattle to Production and Meat Factors.—Branaman, G. A., Hankins, O. G., and Alexander, Lucy M.—

Proc. An. Prod., for Nov. 27-28, 1936, 295-300. 1937. (Journal Article No. 275 (n. s.) from the Michigan Agricultural Experiment Station.)—A total of 72 calves of purebred Hereford breeding were used in this study. Periodic killings were made of heifers and steers at the end of each of four intervals of feeding. The increase in fat (ether extract) content of the dressed carcasses was from approximately 13 to 33 per cent, the percentage of fat in the most highly-finished cattle being about 2.5 times as large as that in the cattle having the lowest degree of finish. Market grades varied from low good to prime. In every case a greater gain and consequently a heavier weight were necessary among the steers than among the heifers to produce similar fatness. There was a general trend toward a greater net energy requirement in the ration for increased fatness in the cattle. There was an increase in dressing percentage to the extent that the fattest cattle produced 53 pounds more chilled carcass per 1,000 pounds live weight than did the least-fat cattle. A marked increase in the ratio of edible meat to bone also accompanied the fat increase. Firmness of lean and marbling increased, although colors of lean or of fat were not materially changed. Average scores for a committee of 3 to 5 persons, who endeavored to measure carefully differences in palatability of the roasted prime ribs, indicated progressive improvement in intensity and desirability of flavor of lean, and in quantity and quality of juice. Tenderness showed little or no change as judged by the committee or as tested by mechanical means.

Further Studies of Transpiration Rates of Fruiting Canes and Current Season Shoots of the Black Raspberry.—Marshall, R. E.—Proc. Amer. Soc. Hort. Sci. 34: 389-394. 1936. (Journal Article No. 276 (n. s.) from the Mich. Agr. Exp. Sta.)—Differences in rates of water loss from leaves of fruiting canes and current season shoots of the black raspberry are not of sufficient magnitude to account for the rather pronounced differences in physiological behavior, such as yellowing of cane foliage, apparent loss of vigor of canes, and failure to maintain production of large, succulent berries with the advance of the fruiting season. Very close relationships were found to exist between such factors as soil moisture supply, temperature, humidity, and sunshine and response of the plant. Vigorous shoots are grown and larger crops are produced the succeeding season when the air humidity is relatively high, when the mean and maximum daily summer temperatures are moderate, when the percentage of sunshine is high, and when a liberal supply of soil moisture is available.

A Progress Report on Comparisons of High-Calcium and High-Magnesium Limes in Bordeaux on Sour Cherry, and in Zinc-Lime and Iron-Lime Mixtures on Peach.—Rasmussen, E. J.—Proc. Am. Soc. Hort. Sci. 34: 279-284. 1936. (Journal Article No. 277 (n. s.) from the Michigan Agricultural Experiment Station.)—High-magnesium lime bordeaux appears to contain copper in a more stable form, to cause less defoliation and to have a less dwarfing effect on Montmorency cherries than high-calcium lime bordeaux during a year of low rainfall. The concentration of both high-magnesium lime and high-calcium lime bordeaux was found to influence growth of shoots and trunks, size of fruit and per cent of solids in fruit, the lower concentration

having the least dwarfing effect. All the zinc sulphate and iron sulphate lime mixtures gave satisfactory control of arsenical injury on peach. The best control was obtained on the plots sprayed with 6-6-100 and 8-8-100 high magnesium- lime iron sulphate mixture. The high-calcium lime zinc sulphate mixture caused less defoliation than the high-magnesium lime zinc sulphate mixture. Zinc oxide and manganese sulphate in combination with high-calcium lime were unsatisfactory. Zinc sulphate used without lime in combination with lead arsenate caused serious defoliation.

The Influence of Some Climatological Factors on Seed-Stalk Development and Seed Yield of Space-Isolated Mother Beets.—Kohls, H. L.—Jour. Amer. Soc. Agron. 29 (4): 280-285. 1937. (Journal Article No. 278 (n. s.) from the Michigan Agricultural Experiment Station.)—A study of the influence of climatological factors upon the percentage of beets that produced seed stalks and seed yields of space-isolated mother beets was made at East Lansing, Michigan. The data were for nine years and were divided into half-month periods. The periods and weather conditions most favorable to a high percentage of beets with seed stalks were found to be a cool, (less than 69.37° F. maximum temperature) wet, (more than 1.68 inches of rain) cloudy, (less than 10.6 hours of sun per day) May 16 to 31, with similar weather conditions extending into the last half of June. The periods and weather conditions most favorable to a high yield of seed are the same periods and conditions that are especially favorable for seed stalk development and a cool (less than 81.44° F. maximum temperature), dry (less than 1.06 inches of rain), July 1 to 15.

White Coating on Foliage a Repellent for Potato Leafhopper.—McDaniel, E. I.—Jour. Econ. Ent. 30 (3): 454-457. 1937. (Journal Article No. 279 (n. s.) from Michigan Agricultural Experiment Station.)—The potato leafhopper, *Empoasca fabae,* is repelled by any white coating on the foliage. The tests were carried out on dahlia, alfalfa, and potato. Hydrated lime, talc and flour were used because they were cheap and because they were available. On dahlia all plants dusted escaped injury from the potato leafhopper and produced normal growth and many flowers while the checks were stunted and produced no flowers. Alfalfa, dusted, remained green and vigorous long after check plots dried up and potatoes protected by dust gave an increased yield of 23 bushels per acre. Of the dusts used, hydrated lime was the most satisfactory since it adhered to the foliage best.

A Comparison Between Actual Plat Yields and Those Calculated from Grain-straw Ratios.—Davis, J. F., and Cook, R. L.—Soil Science Society of America Proceedings, Vol. 1, 1937. (Journal Article No. 281 (n. s.) from the Michigan Agricultural Experiment Station.)—In an effort to shorten the time required for the threshing of the grain from large field plats, a comparison was made between actual plat yields and yields calculated from the total grain and straw weights and the grain-straw ratios. Such ratios were obtained by threshing one, two, and three bundles from each plat. Correlation coefficients between the actual and calculated yields ranged between .93 and .98 depending upon the number of bundles used in obtaining the grain-straw ratios and

the particular grain crop in question, whether wheat, oats, barley, or mixed grain. The standard error of estimate between the actual and calculated yields decreased with an increase in the number of bundles used in obtaining the grain-straw ratios.

When plat yields of barley were subjected to the analysis of variance, the final results obtained with the calculated plat yields varied but little from those obtained with the actual plat yields.

The Dilatometer Method for Determining the Moisture Equivalent of Soils.—Bouyoucos, G. J.—Soil Science 43 (5): 385-389. 1937. (Journal Article No. 285 (n. s.) from the Michigan Agricultural Experiment Station.)—The dilatometer method for determining the moisture equivalent of soils possesses the following advantages:

(a) It is comparatively free from the influence of external factors and is consequently less empirical, and the results are on a more nearly absolute basis.

(b) It makes two important determinations at the same time—the moisture equivalent and the wilting point.

(c) It is rapid and simple.

(d) The apparatus required is simple and inexpensive.

A Rabbit Ovulation Test for Equine Pregnancy.—Arnold, J. J.—Vet. Med. 32 (7): 324-327. 1937. (Journal Article No. 286 (n. s.) from the Michigan Agricultural Experiment Station.)—Directions are given for making the test together with the results of a series of trials.

A Comparison of the Microscopic Test, Hotis Test and Blood Agar Plate in Detecting Streptococci of Mastitis in Milk.—Bryan, C. S. and Devereux, E. D.—Cornell Veterinarian. 27: 67-73. 1937. (Journal Article No. 288 (n. s.) from the Michigan Agricultural Experiment Station.)—In comparative studies the culture in blood agar detected an average of 89 per cent of all milk samples that were shown to contain mastitis streptococci in the microscopic test. Considering the results of the microscopic test as accurate in detecting the presence of mastitis streptococci, the 24-hour reading of the Hotis test detected from 52.8 per cent to 64.3 per cent of the composite samples positive in the microscopic test. The results of the 48-hour reading of the Hotis test detected from 62.2 per cent to 71.4 per cent of the composite samples positive in the microscopic test. When quarter samples of milk were tested, the 24-hour reading of the Hotis test detected 64.3 per cent and the 48-hour reading detected 78.6 per cent of the samples positive in the microscopic test.

The Hotis test gives rise to many suspicious reactions; these do not permit a definite determination of the presence or absence of mastitis streptococci. The results of the Hotis test are not constant on repeated testing of milk from positive or negative cows, the results remaining negative or positive in the microscopic test and blood agar plate during this time.

The Winterhardiness of Weeds.—Dexter, S. T.—Jour. Am. Soc. Agron. 29: 512-517. 1937. (Journal Article No. 292 (n. s.) from the Michigan Agricultural Experiment Station.)—Samples of rhizomes from fertilized and unfertilized quack grass, roots of Canada thistle, and field bindweed and crowns of downy brome grass were collected at weekly

intervals during the fall. Tests of their ability to endure low temperatures showed that they became more hardy as cold weather came on. Canada thistle was found to be relatively susceptible to injury by freezing. If photosynthesis was prevented in the fall, quack grass fertilized with nitrogen failed to harden, while unfertilized quack grass rhizomes hardened considerably, although not as well as if photosynthesis was permitted. Alfalfa roots and crowns were found to be able to withstand lower temperatures than Canada thistle or bindweed roots. Quack grass rhizomes from unfertilized plats were hardier than those from fertilized plats. The applicability of some of these principles to the control of quack grass on a field scale is described.

A Critical Study of Various Types of Detergents and Disinfectants for Use in Dishwashing.—Mallmann, W. L.—Am. Jour. Public Health. 27 (5): 464-470. 1937. (Journal Article No. 297 (n. s) from the Michigan Agricultural Experiment Station.)—Various detergents were found to differ in their power to remove bacteria from dishes. The addition of sodium hexametaphosphate in detergent mixtures aided in the removal of bacteria. Hot water under field conditions was found to provide the most practical means of sanitizing dishes and silver. For mechanical dishwashing it is suggested that the wash water temperature be maintained at 140° F., and the rinse water at not less than 170° F. For cold water sterilization the use of chlorine sterilizers or comparable compounds that are easily checked by simple tests is recommended. An inspection service of restaurants and beverage establishments should include a bacteriological check of the sanitary quality of dishes and silverware.

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LIST OF AVAILABLE BULLETINS

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262 Suggestions on Planting Orchards.

Special Bulletins—

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Circulars are briefly and concisely written discussions of a popular nature.

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SHORT-TERM LOANS TO FARMERS BY MICHIGAN COUNTRY BANKS

R. J. BURROUGHS AND S. K. FRISBIE[1]
SECTION OF ECONOMICS

Purpose and Scope—Are farmers good or poor risks for a commercial bank? Do farmers need credit for mere seasonal requirements, or must they rely on the banks for intermediate credit or permanent working capital? How do farmers compare with merchants and manufacturers in this respect? To what extent are variations in risk and liquidity of bank loans to farmers associated with the purposes for which the funds are borrowed, or with the production type of farming practiced by the borrower?

Those and numerous other questions are being studied in a survey of selected Michigan country banks situated in various farming areas. The survey has benefited from the active co-operation of the Michigan Bankers Association in making records available. In the summer of 1936 transcripts were taken of the ledger record of 100 borrowers in each of five banks. Several other banks are being added to the survey while this is being written. These transcripts of loan records give a complete history of the loan relationships of the banks to the farmers for the period since Jan. 1, 1928. Although the sample was selected from the customers of 1936 or 1937, some borrowers were not customers for the entire period, either because they came into the community since 1928 or for some other reason. On the other hand, no doubt there were customers in the early years of the survey who were not 1936 customers, and who therefore were not included in the sample. Partly to compensate for this bias, in some instances those borrowers who had been customers from time to time over the entire period were tabulated separately.

To determine the uses to which the loan funds were put, a questionnaire was sent to each farmer over the signature of the local bank executive. Replies were received from 50 to 60 per cent of the cases. Tabulation of those loans is complete for a Jackson County bank and will soon be completed for four other banks.

Finally, as a check against some of the results obtained from the limited number of banks (which on the whole were probably managed more capably than the average), and as a means of broadening the scope of the study, questionnaires were mailed by the Michigan Bankers Association to 380 country banks from which 110 replies were received.

[1]Dr. Herman Wyngarden, Professor of Banking of Michigan State College, originated the idea on which this research program was planned. His counsel and that of Dr. H. S. Patton, Chairman of the Department of Economics, have been constantly sought and given.

Preliminary Results in Jackson County Bank—In order that one may interpret the fluctuations of the volume of borrowing and the quality of loans in a Jackson County bank, the recitation of a number of miscellaneous facts is in order. The bank is situated in a general farming section which raises wheat and beans as cash crops, with corn, wheat or rye, oats or barley, hay, and potatoes as other elements of the crop rotation. Dairying ranks as the leading livestock enterprise supplemented by sheep, hogs, and poultry. Of the 100 borrowers selected for study, 65 do general farming, 4 are dairymen, one raises fruit, while 30 are unclassified from lack of definite knowledge. Undoubtedly most of the unclassified belong to the general farming category.

The farms of the borrowers are predominantly "sixties" and "eighties," with virtually all farms falling within the 60- to 160-acre range. The money borrowed was used principally to operate those farms. Of 574 loans to borrowers answering the questionnaire, only 13.2 per cent was reported used for personal consumption. Furthermore, the money borrowed was usually in small amounts. More than 71 per cent of loans of new or additional money (as distinguished from the total obligation of the borrower at any one time) were for amounts under $125 while more than one-half were for less than $75. Over one-sixth of the loans were for less than $25.

These 574 loans, used primarily for operating and largely confined to small advances, were secured in 62.5 per cent of the cases only by the single name promissory note of the borrower. There were relatively few chattel mortgages but many "property notes," which are said to be the equivalent of a chattel mortgage but unrecorded. The most frequently used collateral security was an endorsement by a friend or a member of the family. Endorsements by a near relative or especially by a wife may have moral effect, but such an endorsement would not be likely to increase nor to bind with any more legal thongs the capital assets serving as security.

With few exceptions, the interest charged for these 574 loans was 7 per cent. This was true in prosperity and in depression.

The foregoing facts have characterized the loans of the Jackson County bank in a number of particulars. The following observations pertain to fluctuations in the quantity of credit and to measurements of the quality of credit inherent in these loans.

First, with respect to the variation in the amount of borrowing from season to season and from year to year, it was noted that seasonal

Table 1. Seasonal index of quarterly balances for fifty-four continuous customers.*

Quarter Ending	Index
March 31	102.8
June 30	101.0
September 30	96.8
December 31	99.5

*For borrowers appearing in 1927 or 1928 who repeat in 1935 or 1936. The average of the sum of the aggregates of the four quarters is the base.

changes were inconsequential but cyclical changes were considerable. An accompanying table pertains to the seasonal variation in credit (Table 1).

A virtual absence of seasonal change in this bank in the general farming territory is in distinct contrast to the observations made in other farming areas, the results of which will appear in a future publication.

The cyclical fluctuation in the volume of credit, corrected for seasonal variation, and compared with a number of other series is presented in the accompanying Table 2. The indices have all been converted to a 1931 base, but the index of quarterly balances is for the last day of the respective years, while the other series are averages of annual data.

The closest correlation was obtained between the volume of loans to the sample farm borrowers, and loans of all member and non-member banks of the nation to all classes of borrowers. Both of these indices lagged somewhat behind business and agricultural changes. This lag which has already been observed[2] would seem to signify that business and agricultural fluctuations are the cause, and bank credit the effect. However, such a simple conclusion is to be questioned as the voluminous literature of the business cycle suggests.

Table 2. Fluctuations of balances of sample accounts compared with fluctuations of other banking and agricultural indices.

Year	Index of Balances for 54 Continuous Customers[1]	Index of Loans of Member and Non-Member Banks[2]	Index of Prices Paid Farmers for Michigan Farm Products[3]	Index of Michigan Farm Costs[4]	Ratio of Farm Prices to Farm Costs[5]
1927	121.2	123	156	126	125
1928	121.5	130	163	126	129
1929	125.8	134	165	126	130
1930	118.1	122	142	118	121
1931	99.7	100	100	100	100
1932	94.0	83	69	82	85
1933	85.8	70*	74	75	97
1934	59.5	65	93	82	114
1935	74.5	65	113	86	132

[1] Borrowers appearing in 1927-1928 who repeat in 1935-1936. The base is the average of the relatives of December 31st of each year.
[2] 22nd Annual Report of Board of Governors, Federal Reserve System, 1935, Table 48, p. 135. (December 31, 1931 = 100)
[3] Michigan Technical Bul. 139, p. 8. (1931 = 100)
[4] Michigan Technical Bul. 139, p. 28. (1931 = 100)
[5] Michigan Technical Bul. 139, p. 28. (1931 = 100)
*(December 30, 1933)

Second, with respect to the quality of credit inherent in these 574 loans, not a single loss has ever been admitted by the banker. Some loans have been very slow, some lines of credit are not being reduced to any extent, if at all, but the banker is confident that every loan will ultimately be collected. In fact, in none of the banks so far studied has a loss been taken on a loan to a farmer on short-time account. There may have been some small losses on farm real estate loans when these

[2] Hardy, Charles O. and Viner, Jacob, "Report on Availability of Bank Credit in 7th Federal Reserve District, Submitted to Secretary of Treasury," Foreword p. V, par. 4.

loans were assumed by the Farm Credit Administration or as the result of foreclosure. There have been losses on loans to merchants and industries, but so far as the detailed study of individual banks has been carried, not a single loss on a short-time loan to farmers has been isolated. No doubt some paper will yet be written off, and no doubt some banks have suffered such losses on farm paper as the answers to the questionnaire described below will reveal. But the most outstanding fact so far observed is that loans to farmers are comparatively safe.

However, some bankers will contend that loans to farmers are slow. A detailed study has been made of this issue. Space permits only the brief comment that approximately half the farm borrowers in the Jackson County bank "clean up" their indebtedness to the bank at least once a year and that about 70 per cent of new loans are completely paid back to the bank within a year. It remains to be seen whether loans to farmers in livestock, fruit, or other farming areas will show a higher or lower degree of liquidity. The absence of any marked degree of seasonality in the general farming territory suggests that farm loans will be somewhat less liquid in general farming than in other areas, but this inference has not yet been tested.

Finally, in the study of the quality of farm credit, a number of factors with which high or low liquidity may be associated are under examination. At this stage of the study it may only be reported that the purpose for which money is borrowed does not determine with any degree of certainty the period within which a loan will be paid. Perhaps the quality and type of farm and habits of the borrower are more significant. It is true that in the Jackson County bank loans for the payment of labor, for the purchase of seed and fertilizer, and stock feed prove somewhat more liquid than loans for other purposes, although the difference between one purpose and another is not sufficiently great to be very significant.

Replies to Questionnaire by 110 Banks—Replies to the questionnaire sent under the auspices of the Michigan Bankers Association to 380 Michigan country banks, verify the tentative conclusion of the detailed study just discussed that loans to farmers are relatively safe loans and possessed of an average degree of liquidity. An accompanying tabulation shows 9 of the 16 questions asked, together with the replies. Only those questions pertaining to the quality of farm credit are reproduced here, while questions concerning other topics are omitted. Real estate mortgage loans are not under review in the questions dealing with loans to farmers.

3. Have your principal losses been in customers' loans or on outside investments?

Customers' Loans	5
Outside Investments	89
Equal	5
Unknown	11
	110

4. In proportion to amounts loaned, have you lost most on farmers, merchants, or to industries?

Farmers	20
Merchants	16
Industries	24
About Same	8
Unknown	42
	110

5. In proportion to amounts loaned, on which of these three have you lost least?

Farmers	51
Merchants	20
Industries	9
About Same	11
Unknown	19
	110

6. Specifically, on what kind of paper have you taken your principal losses?

CUSTOMERS' LOANS		40
Individuals	5	
Farmers	10	
Merchants and Industry	16	
Unsecured Notes	9	
OUTSIDE PAPER		55
Bonds	25	
Real Estate Mortgage and Mortgage Bonds	23	
Other	7	
Unknown		19
		114
Duplicates		—4
		110

7. What proportion of farmers' notes are paid at maturity? Paid in part? Renewed in entirety?

PER CENT	PAID AT MATURITY	PAID IN PART	RENEWED IN ENTIRETY
0—9	2	4	11
10—19	9	6	21
20—29	23	30	36
30—39	12	12	8
40—49	6	13	3
50—59	27	14	8
60—69	7	6	1
70—79	5	4	1
80—89	1	5	1
90—99	2		1
100	1		
Unknown	15	15	15
	110	109	106

8. Do merchants need or get renewals as often as farmers?

Yes	59
No	40
Unknown	11
	110

9. Do manufacturers need or get renewals as often as farmers?

Yes	21
No	38
Unknown	51
	110

10. If you were to compel every customer to "clean-up" his obligations at least once a year, do you have enough business to permit you to operate at a profit?

Yes (Based in part on investments)	51
No	55
Unknown	4
	110

11. In such a case would you need to increase your volume by purchase of much outside paper?

Yes	70
No	26
Unknown	14
	110

The story told by these replies seems to be that banks have lost more money on outside investments than they have on loans in their own rural community although answers to questions three and six are not entirely consistent. Questions four and five, taken together, seem to indicate that loans to farmers have resulted in proportionally smaller losses than loans to commerce and industry. Losses have been rather heavily concentrated in bonds and real estate mortgages. The liquidity of farm accounts appears to compare favorably with the accounts of rural merchants and rural industries.

Conclusion—If an attempt were made to force every borrower to pay his bank indebtedness once a year, the banks would be forced into purchase of outside paper. Evidently it would require a greatly improved investment policy to avoid the same mistakes that were made before. Some banks now utilize an independent investment counsel. In the interest of those banks which do not employ such counsel it is hoped that the great city banks will improve their leadership in this field by regarding their position of pre-eminence as a public trust.

As every banker knows, the volume of short-time open market paper is so extremely limited[3] that most extensions of credit, other than loans to customers, must of necessity be in long-term issues—governments, municipals, railroads, industrials, or real estate. In view of the demand liabilities of the commercial bank and the impossibility of achieving a satisfactory degree of liquidity, one of the important banking issues before the country today is whether to separate the loan from the depository function as proposed by the Irving Fisher school of thought,[4] or to continue extremely liberal discounting as legalized by the banking act of 1935 which is in conformance with the views of Chairman Eccles of the Board of Governors of the Federal Reserve System.

1936 DAIRY COSTS IN MICHIGAN

K. T. WRIGHT AND A. C. BALTZER
SECTIONS OF FARM MANAGEMENT AND DAIRY HUSBANDRY

The fifth and final year of the dairy cost study being conducted by the farm management and dairy sections was completed in July 1937. Those cost accounts which took into account all items of expense and income showed a net return of $234 per herd (Table 1). This was above all charges, including $468 for labor caring for the cows and an allowance of $207 for management of the dairyman. The herds had an

[3]Outstanding commercial paper of $329,000,000 and dollar acceptances total $344,000,000 in August 1937. These inconsequential sums may be compared with the $32,739,000,000 comprising the total loans in investments of member banks as of June 30, 1937. Federal Reserve Bulletin, October 1937, p. 1024, p. 1018.

[4]Fisher, Irving, "100% Money," Adelphi Co., Rev. Ed., 1936.

average production of 347 pounds of butterfat per cow during the year, averaging 13 cows per herd under test in the Dairy Herd Improvement Association.

The average cost per cow in the herds studied totaled $152.58 for the year. Of this total, 43 per cent was for feed, made up of $32 for 2,362 pounds of grain, $24 for 7,260 pounds of roughages and $9 for pasture. The labor and management charge was approximately $52 a cow, making up 32 per cent of the total expense. These two items constituted three-fourths of the total cost, with many other items accounting for the remaining one-fourth.

Credits for the products sold and used on the farm amounted to $170.68 a cow as an average, making a net return of $18.10 for the year. Return for labor and management, however, was that net return plus the charges for labor and management, or a total of $70.41 a cow. This amounted to 48 cents an hour for all the time spent on those high producing cows during the year.

The charges for producing 100 pounds of milk, testing 4.3 per cent, averaged $1.90 at the farm during this period. The total cost of producing a pound of butterfat was 44 cents, as an average, with the lowest cost on an individual farm being 32 cents and the highest 67 cents.

Table 1. Dairy costs and returns on 123 Michigan D. H. I. A. herds, 1936.

Item	Per Farm (12.9 cows)	Per Cow	Per Cwt. Milk	Per Pound Butterfat
Butterfat production (lbs.)	4,470	347		
Milk production (lbs.)	103,625	8,032		
FEEDS:				
Concentrates (lbs.)	29,190	2,262	28.2	6.5
Hay (lbs.)	44,535	3,452	43.0	10.0
Silage and other roughage (lbs.)	62,033	4,808	59.8	13.9
Pasture days	2,176	169	2.1	.5
Hours man labor	1,874	145	1.8	.4
CHARGES:				(cents)
Feed	$850	$65.94	$0.82	19.0
*Man labor	465	36.31	.45	10.5
*Management	207	16.00	.20	4.6
Buildings and equipment use	111	8.62	.11	2.5
Interest on cow value	68	5.23	.07	1.5
Bull expense	57	4.44	.06	1.3
Other items	207	16.04	.19	4.6
**Total	$1,968	$152.58	$1.90	44.0
CREDITS:				
Dairy products	$1,920	$148.80	$1.85	42.9
Manure	148	11.44	.14	3.3
Calves and other items	134	10.44	.13	3.0
**Total	$2,202	$170.68	$2.12	49.2
NET RETURN	234	18.10	.22	5.2

*Man labor was figured at 25 cents an hour, or slightly more than was paid the hired help in 1936. Operators of these farms did 64 hours of the work on each cow. Their work was charged at 50 cents an hour. This 25 cents difference was entered as management.

**At the farm. Marketing costs deducted from receipts.

Factors Affecting Costs and Returns

Production Per Cow—It has just been indicated that the cost of producing a pound of butterfat was twice as high on one farm as on

another. Some of the difference in cost was due to feeding efficiency, some to labor efficiency, part to other expense items, and a large part to difference in production per cow. Butterfat production of the herds in this study ranged from 165 to 485 pounds per cow, and averaged 347. To produce butterfat on the eight farms where the cows averaged less than 250 pounds of butterfat per cow, cost 55 cents a pound, and 41 cents on those producing over 400 pounds butterfat per cow. The 8 low-producing herds lacked $11 a cow of paying costs, while the 19 high herds had a net return of $40 a cow. Thus, there was $660 higher net return on the high-producing herds. Stated another way, the return per hour labor was 29 cents on the low-producing herds and 63 cents on the high. Thus, each dairyman determined to a great degree his own labor wage or return per hour.

Table 2. Relation of production per cow to costs and returns, 1936.

Item	Average Butterfat Production per Cow (lbs.)				
	221	284	326	374	431
Number of herds	8	21	30	45	19
Milk per cow (lbs.)	5,337	6,648	8,011	8,573	9,345
Grain per cow (lbs.)	648	1,450	2,218	2,505	3,058
Roughage per cow (lbs.)	9,172	6,921	8,160	8,623	8,546
Feed cost per cow	$43	$51	$64	$70	$82
Labor per cow (hrs.)	113	128	156	149	150
Total cost per lb. butterfat (cents)	55	48	48	44	41
Return per hour labor (cents)	29	41	41	53	63

Feeding Efficiency—The 25 herds having the lowest feed cost per pound of butterfat had an average feed cost of 11 cents compared with 20 cents a pound butterfat on the 25 high-feed-cost herds. The low-cost herds were fed an average of 487 fewer pounds of concentrates per cow, 1,100 pounds less hay, 1,600 pounds less silage, yet produced practically as much per cow as the high-feed-cost cows.

Cereal grains made up 35 per cent of the total grains fed the low-cost herds and 40 per cent for the high-cost herds. More than 80 per cent of the concentrates mixed with the cereals for feeding the low-cost herds were soybeans or soybean-oilmeal, whereas, more than one-third of the concentrates fed the high-cost herds were 16 per cent

Table 3. Feeding efficiency and dairy costs, 1936.

Item	Low-cost Herds	High-cost Herds
Butterfat production per cow (lbs.)	336	342
Concentrate cost per cwt	$1.13	$1.67
Feed cost per cow per year	47.51	82.18
Concentrate per lb. butterfat (lbs.)	5.7	7.0
Hay per lb. butterfat (lbs.)	9.0	12.0
Silage per lb. butterfat (lbs.)	10.8	15.3
Days on pasture	175	160
Digestible protein of concentrate (per cent)	10.4	11.4
Total digestible nutrients of concentrate (per cent)	76.4	73.0

and 20 per cent dairy feeds. The grain ration fed the low-cost herds contained 10.4 per cent digestible protein and 76.5 per cent total digestible nutrients while the high-cost herds received a mixture containing 11.4 per cent digestible protein and 73 per cent T. D. N. Each 100 pounds of grain feed given the low-cost herds cost $1.13 and $1.67 for the high-cost herds.

The low-cost herds averaged 12.1 cows each using 40 acres pasture while the high-cost herds averaged 14.8 cows each using 45 acres pasture. For both groups one-third of the pasture was tillable and two-thirds permanent. The types of tillable pasture acreage used by the low-cost herds were alfalfa, sweet clover, Sudan grass and June grass, and for the high-cost herds sweet clover, clover-timothy mixed, June grass, and alfalfa. The low-cost herds averaged 15 days longer pasture in the year than the high-cost herds.

Labor Efficiency—The 123 records were divided into three groups based on the labor charge per pound butterfat (Table 4). In the low-cost group only 107 hours were spent per cow during the year, and the cows produced 366 pounds of butterfat, while 186 hours were spent per cow in the high-cost herds, averaging 312 pounds butterfat per cow. The low-cost men spent 51 less hours milking their higher producing cows than the high-cost men, largely because three times as many had milking machines. Equipment expense as a result, was one dollar a cow higher. Less time also was spent in feeding and other work, so the labor charge was slightly less than one-half as much per pound butterfat on the low-cost herds. If all labor was figured at 25 cents an hour, the labor and equipment charge per cow was $29 on the "efficient" group and $48 on the high-cost group.

Table 4. Labor efficiency and dairy costs, 1936.

Item	Labor Cost per Pound Butterfat		
	Under 9 cents	9 to 12 cents	12 cents up
Number of farms	41	42	40
Per cent using milking machines	61	29	20
Cows per farm	14	13	12
Butterfat production per cow (lbs.)	366	356	312
Equipment cost per cow	$2.71	$1.94	$1.79
Hours labor: (per cow)			
Milking	68	100	119
Feeding	19	23	29
Other work	20	26	38
Total hours	107	149	186
Labor cost per lb. butterfat (cents)	7	10	15
Total cost per lb. butterfat (cents)	41	45	51
Return per hour labor (cents)	72	46	34

Size of Herd—The number of cows in the herd had an influence on labor efficiency. Herds in this study ranged from 5 to 34 cows. The 9 smallest herds averaged 6 cows, and the 14 largest (19 cows or more) averaged 23 cows. The dairymen spent an average of 157 hours per cow on the "small" herds and 134 on the "large". All items of expense,

other than feed and management, amounted to $94 a cow for the year on the "small" herds and $70 on the "large" herds, or a difference of $24, due largely to difference in size of herd. Net return per cow, however, was highest on herds ranging from 10 to 16 cows.

Method of Milking—In this group of 123 dairymen, 45 milked with machines. About 11 per cent of those with herds under 10 cows used machines, 45 per cent of those having 10 to 16 cows, and one-half of those with herds of more than 16 cows. For the small herds, there were 28 less hours of labor per cow, but $3.85 extra equipment expense where machines were used. On medium-sized herds, the dairymen with machines spent 45 less hours per cow in the year and had $2.44 extra equipment expense. For the large herds, there were 16 less hours per cow and $2.10 higher equipment cost. Thus, the saving of time cost around 14 cents an hour on the small herds, five cents an hour on the medium sized herds, and 13 cents an hour on the large herds. Whether the farmer can use his labor to return more per hour than the above amounts determines the profitableness of having a milking machine.

Milking Machine Costs—Detailed cost records were available on 45 milking machines. There were 14 DeLaval, 8 Surge, 6 Empire, and 17 others. The average value placed on the machines at the beginning of the year was $120. Depreciation averaged $8.45, interest $7.20, repairs and supplies $4.89 and power $13.89 for a total of $34.43 per machine for the year. Since herds on which machines were used averaged 14.2 cows, milker use cost $2.42 a cow.

Bull Costs—Only 11 of the 123 farmers paid bull fees, and all the others either owned one or two bulls, an interest in a bull, or had one part time. Complete 12-months records were available on 75 bulls. Those bulls in the course of a year consumed an average of 577 pounds of concentrates, 4,855 pounds of hay, 2,652 pounds of silage, 176 pounds of other roughage, and were on pasture an average of 20 days. This feed was valued at $42.56 in 1936. Time spent in care of the bulls averaged 89 hours. Total cost amounted to $86.73 per bull for the year, while net bull cost, after deducting credit for $11 manure, $7 appreciation and $5 for fees received, was $63.56 or $4.85 per cow in the herd.

SUPPLEMENTS TO HAY FOR WINTERING BREEDING EWES

LEONARD H. BLAKESLEE, G. A. BROWN, AND J. G. WELLS, JR.
SECTION OF ANIMAL HUSBANDRY AND UPPER PENINSULA EXPERIMENT STATION[1]

The flock of 120 breeding ewes, located at the Chatham Sub-station, is maintained as an experimental flock. The breeding and feeding tests conducted there previous to 1934 are reported in Special Bulletin 255.

[1]The authors desire to acknowledge the faithful and untiring efforts of Albert Sautter, herdsman, and Helmi Niemi, clerk, at the Upper Peninsula Experiment Station, in conducting the experimental work and compiling records.

This report summarizes the results of three years' work completed since 1934.

Object and Plan of Experiment

The object of this experiment was to study the comparative merits of legume hay versus legume hay and barley versus legume hay and cottonseed meal as winter rations for breeding ewes.

Rams are turned in with the breeding flock about November 1. One month later the flock is divided as evenly as possible considering condition, age, weight, breeding, shearing ability and thrift, into four different lots. The average daily ration received by each ewe during the gestation period is shown in Table 1.

Table 1. Average daily rations, feed cost and ewe weights.

	Lot I	Lot II	Lot III	Lot IV
GESTATION PERIOD				
Average number days fed	110	110	110	110
Number of ewes	89	89	87	88
Average initial weight (pounds)	152.09	151.17	151.07	152.36
Average final weight (pounds)	167.13	170.79	175.53	182.17
Average gain per ewe (pounds)	15.04	19.62	24.46	29.81
Average daily ration:				
Hay (pounds)	4.04	3.04	2.05	3.04
Barley (pounds)	....	.62	1.24	....
Cottonseed meal (pounds)	....	....	....	.61
Feed cost per ewe	$2.87	$3.03	$3.21	$3.51
NURSING PERIOD				
Average number days fed	47	47	47	47
Lambing per cent	152	150	156	139
Average loss per ewe (pounds)	35.24	33.28	30.92	40.58
Average fleece weight (pounds)	7.97	8.17	8.47	9.42
Average daily ration:				
Hay (pounds)	4.04	3.03	2.01	3.02
*Barley (pounds)	.49	.88	1.43	.49
**Cottonseed meal (pounds)	.25	.25	.25	.69
***Roots (pounds)	1.59	1.62	1.62	1.60
Feed cost per ewe	$1.46	$1.54	$1.56	$1.72
Total feed cost per ewe—December 1 to pasture	4.33	4.57	4.77	5.23

Feed prices used: Hay $12.50 per ton; barley $25 per ton; cottonseed meal $40 per ton; roots $3 per ton; salt 1 cent per lb.

*Barley was fed the entire period to Lot 1 during the first trial and the last 29 days of the second trial. Lot 4 received barley the entire period of trial one and the last 22 days during the second trial.

**Cottonseed meal was fed lots 1, 2 and 3 in the third trial only, and in Lot 4 during all trials.

***Roots were fed the last 39 days to all lots in trial one only.

An average of three successive daily weights was used as the initial and the final weight for the gestation and nursing period. Individual weights were taken each month during the feeding period. Weights are taken on lambs at birth, when turned to pasture, at weaning, and at marketing time in the fall. Each lamb was ear-tagged at birth as a means of identification. The ewe flock was sheared about the first of

May and fleece weights recorded. Approved management practices were followed at all times. Feed was supplied to the ewes during nursing as necessary to properly nurse their lambs.

Discussion of Results

As shown in Table 1, the Lot 4 ewes, receiving 0.6 pound of cottonseed meal with 3 pounds of hay daily, gained an average of 5.35 pounds more than Lot 3 ewes, 10.19 pounds more than Lot 2 ewes and 14.77 pounds more than Lot 1 ewes. While 4 pounds of hay daily is usually considered a good ration for breeding ewes, the gain in each lot clearly shows the advantage and supplementing effect of barley and cottonseed meal. Further evidence of this is the average fleece weights of the respective lots shown in Table 2.

Table 2. Average fleece weights.

	Lot 1	Lot 2	Lot 3	Lot 4
1934	7.24	7.58	7.79	9.26
1935	8.50	8.63	8.99	9.40
1936	8.14	8.35	8.61	9.49
Three-year average	7.97	8.17	8.47	9.42

Good gains are desirable during the gestation period of the breeding flock to insure well-developed lambs at birth, increase the fleece weight, and produce a good flow of milk. However, good gains do not necessarily indicate high milk production unless the nutrients supplied are of the proper kind. Table 3 shows clearly the superiority of the ration including cottonseed meal in producing not only heavier

Table 3. Average weights of lambs, 1934-'36.

	Birth Weights			To Pasture Weights			Weaning Weights		
	All Lambs	Single Lambs	Twin Lambs	All Lambs	Single Lambs	Twin Lambs	All Lambs	Single Lambs	Twin Lambs
Lot 1	9.26	10.37	8.86	20.86	25.45	18.79	72.34	76.80	68.70
Lot 2	8.78	10.46	8.27	22.21	24.92	19.67	69.00	76.35	62.42
Lot 3	8.95	10.29	8.57	19.70	22.78	16.49	68.39	72.15	62.13
Lot 4	10.09	11.37	9.44	25.27	26.73	24.18	79.86	83.65	75.43

lambs at birth, but also heavier lambs when turned to pasture and at weaning time.

All lots dropped a good percentage of living lambs as indicated in Table 1. Lots 1, 2 and 4 weaned slightly better than one lamb per ewe, while Lot 3 weaned less than a lamb per ewe.

The explanation for the heavier lambs in Lot 4 is that a ration with a higher protein content enabled the ewes to produce a greater yield of milk for their lambs. The ration fed the lambs in Lot 1 was also higher in per cent of protein content than that of either Lot 2 or 3, and we find that in practically all cases, except twin lamb to pasture weights, Lot 1 lambs averaged heavier.

Summary

1. The lambs produced from dams receiving 0.6 pound cottonseed meal and 3 pounds of legume hay per day during gestation averaged 0.83 pound heavier at birth, 4.41 pounds heavier when turned to pasture, and 7.52 pounds heavier at weaning than the lambs from dams receiving 4 pounds of legume hay daily. The lambs from Lot 1 ewes receiving 4 pounds of hay averaged heavier at birth and weaning than the lambs from either lot of ewes receiving barley as a supplement to legume hay.

2. The ration of 4 pounds of hay daily proved better than either 3 pounds of hay and 0.6 pound barley or 2 pounds of hay and 1.24 pounds of barley.

3. Based on 10-cent lambs, 30-cent wool, and one lamb produced per ewe, Lot 4 ewes, receiving cottonseed meal, would more than pay for the added feed cost and be in better condition than the other ewes.

Note: Experimental work is now being conducted on the amounts and kind of protein necessary for good milk production in ewes.

CAROTENE (VITAMIN A) IN ALFALFA HAY

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SECTIONS OF FARM CROPS AND DAIRY HUSBANDRY

The quality of alfalfa hay for winter feeding depends not only on its content of proteins, sugars, fats and minerals, but also on its content of vitamins. The green color of hay is usually associated with carotene which is changed to Vitamin A in the animal body.

Vitamin A is one of the essentials in the human dietary. It is usually furnished by milk, butter and green vegetables. The Vitamin A content of milk and butter depends upon the carotene content of the ration fed the cow; consequently, milk from cows fed feeds high in carotene is a better source of Vitamin A than when feeds low in carotene are fed.

In this experiment second cutting alfalfa hay was cured according to three practices; namely, curing in the swath, in the windrow, and in the cock. At various periods during curing, samples were taken from the three lots of hay for analyses of the carotene content. The hay cut at 10 a. m., August 3, was ready to go into the barn at noon August 5, except for that in the cocks. Part of each lot was left in the field until August 7, for the purposes of this study. Practically

no leaves were lost in this experiment from the hay cured in the swath. In ordinary farm practice, many more leaves would be lost from swath-cured than from windrow-cured hay. This loss would depress the carotene content of the swath-cured hay still further. There was no rain on this hay during the entire period of the experiment.

The table gives the results of the experiment. The following points may be emphasized: Up until the time that the hay was rather thoroughly wilted in the swath, destruction of carotene was relatively slow and was equally fast in swath and windrow. At the time the windrow-cured hay was ready to go in the barn, it was as high in carotene as was the cock-cured hay when it was ready to go in the barn.

Since Vitamin A is a very important factor in winter feeding, the advantage of windrow curing in this regard is evident. Furthermore, any method of curing hay that saves the carotene is very likely to save the other valuable ingredients of the forage.

Table 1. The effect of method of curing alfalfa hay on carotene content.

Date	Sampled	Hours After Cutting	Carotene Content when Cured in the		
			Swath	Windrow	Cock
			gammas	gammas	gammas
August 3	10 a. m.	0	270	270	270
3	12 a. m.	2	225	225	
3	2 p. m.	5	210	210	
3	8 p. m.	10	160	175	
4	5 a. m.	19	152	180	
4	11 a. m.	25	147	165	165
4	3 p. m.	29	125	175	
5	12 a. m.	72	85	135	120
7	12 a. m.	120	65	110	120

1936 TRACTOR COSTS IN MICHIGAN

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Fifty-three Michigan farmers cooperated with the Farm Management Department in a study of tractor costs in 1936. This was the third year of the study, and there were 56 tractors on those farms. All of the men kept a Farm Account Book and a record on their tractors. The Tractor Cost Record took into account the cash operating expenses of running the tractor and the fixed expenses of depreciation, interest, and shelter. A charge was also made for the labor taking care of the tractor.

Fourteen of the tractors were one-plow size, 35 were two-plow, and 7 were three-plow. Twelve of the one-plow tractors were general-

purpose type, one was standard type, and one was orchard type. Thirteen of the two-plow tractors were general purpose and 22 were standard. Seven of the standard two-plow tractors were Fordsons. All of the three-plow tractors were standard type.

Yearly Cost—The average yearly cost of using the one-plow tractors was $201.64 for 508 hours of work, see Table 1. The operating cost, which was actual cash outlay and care, made up one-half of the total cost. The fixed cost, which was depreciation, interest, and shelter, accounted for the other one-half.

The two-plow tractors had an average yearly cost of $171.75 for 291 hours of work. Operating cost made up 52 per cent of the total cost and fixed cost the remainder. The three-plow tractors had a yearly cost of $233.33 for 344 hours of work. Operating cost made up 57 per cent of the total cost and fixed cost 43 per cent. Thus, as an average, the actual cash outlay and care of the tractor amounted to approximately one-half of the total yearly tractor cost.

Hourly Cost—The average hourly cost of using the one-plow tractors was 40 cents (Table 1). The cost ranged from 25 cents an hour for a tractor used 967 hours to 73 cents for a tractor used 302 hours.

The average hourly cost of using all two-plow tractors was 59 cents. The cost ranged from 32 cents an hour for a tractor used 207 hours to $2.28 for a tractor used 47 hours. There were four two-plow tractors

Table 1. Yearly and hourly costs of using 56 Michigan tractors, 1936.

Size of tractor	1-plow	2-plow	3-plow
Number of tractors	14	35	7
Tractor age (years)	1.2	5.1	5.4
Tractor value	$604	$471	$472
HOURS USE IN YEAR:			
Drawbar	457	257	203
Belt	51	34	141
Total	508	291	344
Custom	74	54	125
YEARLY COSTS:			
Operating Costs—			
Fuel	$69.88	$54.17	$89.50
Oil	13.13	11.66	18.22
Repairs	11.53	16.95	19.22
Labor (chores)	6.25	6.26	5.72
Auto use	.21	.96	.92
Total	$101.00	$90.00	$133.58
Fixed Costs—			
Depreciation	$60.28	$50.48	$67.93
Interest	34.43	25.46	26.25
Shelter	5.93	5.81	5.57
Total	$100.64	$81.75	$99.75
Total Yearly Costs	201.64	171.75	233.33
HOURLY COSTS:			
Operating (cents)	20	31	39
Fixed (cents)	20	28	29
Total Hourly Costs (cents)	40	59	68
Fuel for 10 hours (gals.)	11.7	18.4	29.1
Oil for 10 hours (qts.)	1.5	2.3	3.4

that were used more than 500 hours each during the year. One of those was used 1,106 hours.

The average hourly cost of using the three-plow tractors was 68 cents. The cost ranged from 46 cents an hour for 332 hours of use by one tractor to $1.66 for 166 hours of use by another.

Relation of Hours of Use to Tractor Costs (2-plow Tractors)— For 35 two-plow tractors the hours of use for the year varied from 47 for one tractor to 1,106 for another. The seven tractors used the least were used an average of 113 hours during the year and had a yearly cost of $111, or an hourly cost of 98 cents (Table 2). The eight tractors used the most were used an average of 583 hours during the year and had a yearly cost of $261, or an hourly cost of 45 cents. Thus, the eight tractors used the most during the year averaged about five times as many hours of work with a yearly cost of more than twice as much as the seven tractors that were used the least. The cost per

Table 2. Relation of hours of use to tractor costs and farm operating efficiency (2-plow tractors), 1936.

Hours use	0–150	151–250	251–350	351–up
Number of tractors	7	10	10	8
TRACTOR DATA:				
Tractor age (years)	8.0	8.2	4.6	3.4
Tractor value	$310	$361	$522	$687
HOURS USED IN YEAR:				
Drawbar	95	175	239	524
Belt	18	19	38	59
Total hours use in year	113	194	277	583
Custom	15	10	52	147
YEARLY COSTS:				
Operating	$59	$70	$92	$140
Fixed	52	65	88	121
Total	$111	$135	$180	$261
HOURLY COSTS:				
Operating (cents)	52	36	33	24
Fixed (cents)	46	33	32	21
Total (cents)	98	69	65	45
FARM ACCOUNT DATA:				
Acres in farm	178	185	196	201
Crop acres	62	81	112	133
Productive animal units*	13	20	26	27
Days of productive work**	394	383	564	603
LABOR AND POWER COST:				
Man labor	$894	$826	$1,264	$1,187
Horse work***	211	171	273	179
Tractor use****	96	128	147	195
Total	$1,201	$1,125	$1,684	$1,561
Per crop acre	$19.37	$13.89	$15.04	$11.74
Per day productive work	3.05	2.94	2.98	2.59

*The number of the various kinds of productive livestock equal in feed consumption to one mature cow.

**The number of 10-hour days required to do the productive work on the farm with average labor efficiency.

***The value of horse work was estimated to be $78 a horse.

****Cost of custom work has been deducted.

hour, however, on the eight farms was only half as much as on the seven farms, all of which emphasizes the fact that the number of hours the tractors were used had a tremendous influence on the hourly costs and thus the efficiency in their use. The tractors used the most were used about 10 times as much for custom work as the tractors used the least. Therefore, where there is an opportunity the hourly cost of operating a tractor can be reduced to some extent by doing custom work.

The relationship of the fixed (non-cash) costs to operating (cash) costs remained about the same for the two-plow tractors in this study regardless of the hours of use. Such a relationship is contrary to common opinion and was due largely to the fact that the tractors used the most were newer than those used the least. The newer tractors, being valued higher, had a larger depreciation and interest charge than the older tractors. New tractors must be used a great many hours if the fixed cost per hour is to be low.

Relation of Hours of Tractor Use to Farm Operating Efficiency (2-plow Tractors)—The charge for man labor, horse work, and tractor use was computed to determine the influence that the hours of tractor use had on those items of cost. The seven tractors that were used the least during the year were on farms averaging 178 acres in size with 62 acres in crops (Table 2). The eight tractors used the most were on farms averaging 201 acres in size with 133 acres in crops. For the farms where the tractors were used the most the yearly cost for man labor was 31 per cent greater, horse work 15 per cent less, and tractor use twice as much as for the farms where the tractors were used the least. On the basis of cost per crop acre, however, the charge for labor and horse and tractor power amounted to about 40 per cent less for the eight farms where tractors were used the most. In terms of cost per day of productive work, the labor and power charge amounted to about 20 per cent less for the farms where tractors were used the most. Consequently, those farms on which the tractors were used the most were operated 20 per cent more efficiently from the standpoint of labor and power cost than were the farms on which the tractors were used the least.

The cost for tractor use on all of the two-plow tractor farms in this study was but 10 per cent of the total labor and power cost. The major share of the labor and power cost was the labor charge. According to the 1936 farm account records for the 53 tractor farms in this study, 44 per cent of the total man labor was used for crops and 56 per cent for livestock and work off the farm.

Tractor Operations—There were 48 tractors for which complete data were available for the operations for which the tractors supplied the power. Both the one-plow and two-plow tractors were used about 90 per cent of the time for drawbar work as an average, while the three-plow tractors were used on the drawbar about one-half the time. The one-plow and two-plow tractors were used more for plowing than for any other operation. A large portion of the drawbar hours of use for the one-plow tractors was for miscellaneous operations. The three-plow tractors were used more for threshing than for any other operation.

DEATH LOSSES INCREASING IN PULLET FLOCKS

Fifteen Years Mortality Records at Michigan Egg Laying Contest Show Pullet Mortality Limiting Poultry Industry

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SECTION OF POULTRY HUSBANDRY

The poultryman's attitude toward pullet mortality has changed materially during recent years. Instead of quietly disposing of dead birds he submits them for a complete postmorten and bacteriological examination. The Michigan Egg Laying Contest with its uniform practices of management, feeding, housing, and size of units offers an opportunity to analyze pullet losses.

Since the beginning of the contest, November 1, 1922, all dead contest birds have been subjected to autopsy in the laboratory of the Michigan State College Department of Bacteriology, and complete records have been kept of the findings. The diseases and conditions contributing to or causing death have been determined by autopsy or by culturing of various organs and tissues. From those records it has been possible to compile the number of deaths in each breed and variety, causes of death in each bird, and the number of deaths each month during the 15 years.

Table 1 shows the diseases and conditions observed in all birds during autopsy or on reading of cultural findings. Occasionally it has been impossible to list definitely any one of the several findings as the primary cause of death. Physiological abnormalities and the findings of lesions of filterable virus diseases are often observed in the same bird.

The diseases and conditions listed in this table are arranged in groups to conform with the present knowledge of the causes of disease as filterable agents, bacteria, parasites and miscellaneous conditions; the latter are sequels of diseases or unexplainable.

This table provides a source of past and present information. The acceptance and use of vaccines against fowl pox and laryngotracheitis and the use of the blood test for pullorum disease are apparent in the decline of these three diseases.

The increase among contest pullets of cannibalism, chronic parasitism, obesity, ruptured oviducts, visceral gout, and kindred ailments refer to flock conditions from which the birds were chosen. The contest management has no control over the factors of breeding, feeding, rearing or disease prevention of prospective contest birds. The in-

[1]These data are a compilation of Contest records and credit is due Dr. H. J. Stafseth, Section of Bacteriology, Professor C. G. Card, Section of Poultry Husbandry and others for their collection and preservation.

creasing prevalance of these conditions warrants the concern of every poultry raiser.

The advent of the fowl paralysis complex of leucosis, lymphomatosis, and neurolymphomatosis as one of the most prevalent findings is graphically shown in this table. A more thorough knowledge of diseases and their manifestations along with better laboratory facilities has been instrumental in more differential diagnoses. Evidence of this is seen in the great reduction in sarcomatosis and the correct classification under leucosis or colibacillosis.

Table 2 shows the total number of pullets of each breed and variety entered in the 15 contests, the total deaths, and mortality percentage of each.

Table 3 shows the number of deaths each month during the 15 years, total deaths, and mortality percentage by months and years. It is noticeable that heavy losses occur during the months of March, April, May, and July. Losses during March, April, and May can be explained in part as due to the depleting influences of heavy egg production at this season. Intensive spring production lowers the disease-resisting power of the birds and they succumb to a variety of conditions and diseases that less productive birds would resist or tolerate. July, the first month of excessive heat in Michigan, stands out as the month of highest death losses. July losses include heat prostrations in addition to the sequels of intensive spring production and the findings of insidious diseases.

A previous compilation of contest records at the close of the eighth contest (Michigan Quarterly Bulletin, Vol. 13, No. 3) gave 18.98 per cent as the average mortality. A similar compilation for the last seven years from October 1930 to the close of the fifteenth contest shows the average mortality for this period to be 26.53 per cent. The average mortality for the 15-year period benefitting from the earlier years of fewer losses shows a lower figure of 22.122 per cent. Either figure shows definitely that pullet losses are the limiting factor of a successful poultry enterprise.

Biologically poultry is classed below other types of farm animals and a higher annual death loss is to be expected. Annual losses of 10 to 15 per cent were accepted as normal at the time the Michigan contest was begun. The increase of pullet losses at present is far in excess of these figures.

Table 1. Diseases and conditions found on autopsy during 15-year period.

Disease or Condition	1922 1923	1923 1924	1924 1925	1925 1926	1926 1927	1927 1928	1928 1929	1929 1930	1930 1931	1931 1932	1932 1933	1933 1934	1934 1935	1935 1936	1936 1937	Totals
Fowl Paralysis Leucosis	5	—	—	—	16	9	12	23	48	55	51	39	50	39	38	385
Lymphomatosis	—	—	—	1	—	1	—	—	2	4	2	30	19	22	22	103
Neuro lymphomatosis	10	8	5	—	—	—	4	2	13	3	34	8	11	—	4	102
Laryngotracheitis	—	—	—	2	9	54	21	67	22	21	11	3	10	6	9	235
Fowl Pox	10	16	9	11	12	17	5	1	23	—	—	11	1	1	—	117
Fowl Cholera	32	25	9	12	—	—	—	—	—	12	12	1	4	—	—	107
Roup	5	10	15	4	1	20	2	7	67	36	19	9	10	14	34	253
Pullorum Disease	7	9	5	3	2	—	3	—	21	13	6	2	2	3	2	78
Colibacillosis	3	—	—	—	—	1	—	1	1	8	20	12	5	6	19	76
Tuberculosis	11	2	8	—	7	1	—	2	2	4	4	—	1	—	4	46
Fowl Typhoid	10	8	—	4	3	3	1	—	1	1	2	—	—	6	1	40
Roundworms	9	9	10	15	9	14	9	5	5	12	8	34	12	12	13	176
Tapeworms	3	4	2	2	8	6	6	5	3	8	16	29	9	10	7	118
Chronic Paraitism	—	—	—	—	—	—	—	3	9	7	8	6	4	14	12	63
Protozoan Diseases	—	1	—	—	5	6	2	3	8	6	3	2	2	4	3	45
External Parasites	—	—	—	—	—	—	—	—	—	1	—	—	1	—	4	6
Ruptured Oviduct	18	17	21	20	28	40	37	57	48	63	31	21	13	10	17	441
Peritonitis	10	14	18	28	14	17	22	11	25	47	13	16	49	22	24	330
Salpingitis	—	—	—	—	4	7	1	7	9	13	39	27	18	29	27	181
Enteritis	15	10	10	6	8	15	8	7	10	11	8	12	19	12	30	181
Diseased Livers	20	21	18	15	21	30	10	5	7	12	15	10	2	6	16	208
Disturbed Digestion	12	9	10	11	6	17	15	4	13	14	19	8	5	13	9	165

Pericarditis	—	4	6	3	12	19	8	3	15	8	4	1	2	2	10	97
Nephritis	1	1	—	2	2	4	4	1	—	5	6	1	6	10	13	56
Dropsy	—	1	—	—	2	2	3	4	—	—	—	—	—	—	2	14
Sarcomatosis	7	9	10	16	20	28	45	14	31	31	16	1	—	—	3	231
Hemorrhages	12	16	14	10	17	25	2	3	17	20	1	9	6	9	16	177
Visceral Gout	12	6	5	10	14	12	5	1	19	16	16	5	7	12	20	160
Canibalism Injuries	9	9	11	—	4	1	9	14	11	5	20	4	13	14	17	141
Tumors	—	2	7	5	6	19	9	2	2	2	2	4	3	1	—	64
Heat Prostration	—	—	2	—	1	—	—	3	—	1	1	8	6	15	1	38
Obesity	—	—	—	—	—	—	2	—	2	3	8	2	4	8	21	50
Pneumonia	4	1	1	—	—	—	3	2	1	3	1	1	—	2	4	23
Abscesses	—	2	4	1	3	4	—	1	3	1	1	2	3	1	2	28
Vent Gleet	—	—	1	1	—	1	—	—	1	2	—	—	—	1	—	7
Septicemia	—	—	—	—	1	1	—	—	1	1	—	—	—	—	—	4
Fungus Diseases	1	—	—	—	—	—	—	—	—	—	—	2	—	—	—	3
Undetermined	22	16	15	11	6	7	19	13	14	11	7	1	5	3	9	159
Undiagnosed	24	19	18	16	11	6	7	17	5	—	—	—	3	8	—	134
Diseases and Conditions	272	249	234	209	252	387	274	288	459	460	404	321	305	315	413	4,842
Total Deaths	251	244	213	203	220	314	224	229	295	318	354	218	236	242	227	3,788

Table 2. Total birds entered in contests by breeds and varieties during the 15-year period.

Breeds and Varieties	1922 1923	1923 1924	1924 1925	1925 1926	1926 1927	1927 1928	1928 1929	1929 1930	1930 1931	1931 1932	1932 1933	1933 1934	1934 1935	1935 1936	1936 1937	Total Birds Each Breed	Total Deaths Each Breed	Per cent Mortality Each Breed
Barred Rocks	216	252	204	204	195	195	260	260	221	182	208	117	104	169	104	2,891	634	21.9
White Rocks	12	12	12	—	13	—	39	39	52	91	78	52	39	104	117	660	200	30.3
Buff Rocks	12	12	—	12	—	—	—	—	—	—	—	—	—	—	—	36	17	47.2
Columbian Rocks	—	—	—	12	—	—	—	—	—	—	—	—	—	—	—	12	—	—
Domingues	—	12	—	—	—	—	—	—	—	—	—	—	—	—	—	12	2	16.6
White Wyandottes	108	60	36	—	13	—	—	26	13	13	26	13	—	—	13	321	85	26.5
Buff Wyandottes	12	12	—	12	—	—	—	—	—	—	—	—	—	—	—	36	9	25.0
S. C. Rhode Island Reds	60	84	120	144	234	156	91	78	78	65	78	13	26	26	65	1,318	285	19.2
R. C. Rhode Island Reds	12	12	12	12	13	39	26	26	—	13	—	—	—	—	—	165		
New Hampshires	—	—	—	—	—	—	—	—	—	—	—	13	13	26	39	91	7	7.7
Black Orpingtons	12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	12	3	25.0
Barnvelders	—	—	—	12	—	—	—	—	—	—	—	—	—	—	—	12	—	—
Black Minorcas	12	12	—	—	—	—	—	—	—	—	—	—	—	—	—	24	5	20.8
White Minorcas	—	—	—	—	—	—	—	—	—	—	13	—	13	13	—	39	15	38.5
Anconas	84	84	36	36	39	26	—	—	—	—	—	—	13	13	13	344	88	25.6
Australorps	—	—	—	—	—	—	—	—	—	—	13	13	—	—	—	26	3	11.5
Lamonas	—	—	—	—	—	—	—	—	—	—	13	—	13	—	—	26	6	23.1
R. C. Brown Leghorns	—	12	—	—	—	—	—	—	—	—	—	—	—	—	—	12	35	25.5
S. C. Brown Leghorns	24	12	12	12	13	13	13	13	13	—	—	—	—	—	—	125		
Buff Leghorns	12	—	12	12	—	26	13	—	—	—	—	—	—	—	—	75	7	9.3
White Leghorns	624	624	756	732	780	845	858	858	923	936	871	559	559	468	494	10,887	2,387	31.9
TOTALS	1,200	1,200	1,200	1,200	1,300	1,300	1,300	1,300	1,300	1,300	1,300	780	780	819	845	17,124	3,788	—

Table 3. Final summary of mortality for the 15-year period, by months.

Month	1922 1923	1923 1924	1924 1925	1925 1926	1926 1927	1927 1928	1928 1929	1929 1930	** 1930 1931	1931 1932	1932 1933	1933 1934	1934 1935	1935 1936	1936 1937	Total by Months	Per cent Mortality by Months
November	4	7	5	9	11	11	11	4	18	19	16	11	16	12	16	170	4.488
December	8	12	21	13	10	37	21	15	27	19	27	14	17	11	12	264	6.969
January	10	21	19	7	11	35	18	15	15	27	21	18	13	20	16	266	7.022
February	19	13	12	11	13	24	20	15	20	19	22	20	23	16	20	267	7.049
March	30	22	*49	25	17	27	21	30	35	33	24	20	20	25	27	405	10.692
April	38	37	19	19	35	26	32	29	24	31	42	11	26	24	16	409	10.797
May	35	32	12	22	32	27	27	29	34	27	46	21	25	18	21	408	10.771
June	29	27	19	16	13	23	14	25	26	34	38	29	20	23	27	363	9.583
July	34	33	12	27	22	33	20	27	35	28	41	23	20	36	21	412	10.876
August	11	18	14	14	14	21	11	21	28	27	30	14	23	20	16	282	7.445
September	14	10	15	10	31	25	20	18	18	28	37	17	18	19	24	304	8.025
October	15	12	11	22	8	24	8	—	15	26	10	20	15	18	11	215	5.676
Date Unknown	4	—	5	8	3	1	1	1	—	—	—	—	—	—	—	23	.607
Total Deaths	251	244	213	203	220	314	224	229	295	318	354	218	236	242	227	3,788	100.00
Number of Birds in Contest	1,200	1,200	1,200	1,200	1,300	1,300	1,300	1,300	1,300	1,300	1,300	780	780	819	845	17,124	—
Yearly Mortality (per cent)	20.9	20.3	17.7	17.0	17.0	24.1	17.2	17.5	22.6	24.4	27.1	27.6	29.9	29.0	26.8	22.122	—

*Seventeen birds disqualified, killed and autopsied to determine cause of non-production.
**Contest beginning moved up one month to October 1st.

CAUSES OF MORTALITY IN CONIFEROUS PLANTATIONS

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Four plantings of coniferous trees at the Dunbar Station near Sault Ste. Marie, Mich., were examined to discover as nearly as possible the chief causes of mortality in each species. A complete history (Table 1) was available for the four plantations considered: two Red pine, one White pine, and one Norway spruce. The Red pine plantations are located on "Bruce very fine sand loam" and "Chippewa very fine sand". Each plantation is growing partially on both types with no appreciable difference in vitality. The White pine is also on "Chippewa very fine sand" and the Norway spruce on "Ogemaw sandy loam" type.

Table 1. Survival of coniferous species in plantations.

	Kind of Stock	Number Planted	Area (acres)	Years Planted	No. Alive Oct., 1936	Per Cent Survival
Red pine a	2–0	10,000	11	9	3,580	35.80
Red pine b	2–0	20,000	22	10	9,092	45.46
White pine	3–0	16,500	17	8	8,129	49.27
Norway spruce	3–0	7,200	6	8	4,189	58.18

Climatic conditions in the summer of 1936 imposed severe restrictions on the growth of trees in the upper peninsula of Michigan. Temperatures were above 92° F. for 6 days continuously and above 80° F. for 13 days continuously. During July there was a daily excess of four degrees above the normal mean of 64° F. Precipitation for the growing season was only 5 inches; the normal is 9 inches. Those accumulated adverse conditions were sufficient to defoliate native poplars. Some plantation trees that had survived less rigorous seasons since planting died. It might be assumed that weather alone was responsible for killing the trees, but thorough examinations led to the conclusion that weather was only a final limiting factor. Other causes were responsible for the original weakening of the trees, which resulted in their succumbing to the unusual climatic conditions.

In making these investigations, each dead tree was carefully examined for external evidence, then dug up and the roots examined. The only trees not taken up were those obviously destroyed by mechanical agency, or completely rabbit-girdled. In drawing inferences as to the causes of mortality of the trees, it is readily acknowledged that in

practically all cases death was due not to one factor alone, but to a combination of causes. In each case, the factor thought to be chiefly responsible was assigned. Doubtless there are errors of interpretation, but in a large number of cases, the cause of death could be assigned with accuracy (Table 2).

Table 2. Causes of mortality in coniferous plantations.

	Number of Trees Killed				Per Cent of All Dead Trees
	Red Pine	White Pine	Norway Spruce	Total	
Choice of site	9	7	419	435	51.7
Poor planting	49	32	139	220	26.0
Rabbit girdle	9	22	10	41	4.8
Heat girdle	9	11	19	29	3.4
Mechanical Damage	0	19	0	19	2.3
Double planting	0	0	16	16	1.9
Freezing	0	0	13	13	1.5
Snow damage	11	0	0	11	1.3
Insect Damage	0	3*	4**	7	1.2
Unknown	13	23	14	50	5.9
Total	100	117	624	841	100.0

*Three trees definitely killed by white pine weevil. About 45 per cent of plantation more or less seriously affected.

**Upper part of stem riddled by unknown insect.

Choice of Site

When trees are planted in areas where much surface water stands in the spring, the roots will come up to the top of the ground. They spread out in a thin layer next to the surface in an effort to avoid the excess water. In summer, they are in the dry surface layers. Many instances of this condition were found, particularly in the Norway spruce where a depression crossed the plantation. Here all the trees were dead, and in practically every case the roots were spread out around the base of the stem in a flat plate-like arrangement.

The soil in the Norway spruce plantation contains more clay and drainage is less rapid than in the sandy soil of the Red pine plantations. However, the same results in tree growth are to be found in both plantations. The presence of excess surface water in lower areas is indicated by dense patches of ferns *(Polystichum sp.)* and in almost every case the Red pine planted there have died. In one of the planta-

Table 3. Soil moisture in red pine plantation.

	(Depth of Water in Inches)					
	May 8	May 10	May 17	May 24	May 31	June 7
Low area	42.00	36.00	20.75	12.50	Dry	Dry
High area	22.00	17.25	10.50	4.50	Dry	Dry

tions about half the area is approximately two feet higher than the rest of the plantation. The soil is physically the same in both places, but a marked difference in growth of the trees is evident. To discover whether or not this might be due to a difference in the water table, a drain tile was set 3 feet deep in each part of the plantation. Depth of water was measured in inches at weekly intervals (Table 3).

Since the tile were set 36 inches below the surface, the 42-inch reading on May 3 indicates 6 inches of standing water on this site. That this excess was not later of any assistance to the trees is indicated by the readings on May 31 when both low and high areas registered dry.

Fig. 1. Red pine which died after 8 years in plantation, due to improper planting.

In addition to the adverse influence of free water in the early spring, another detrimental influence was discovered when setting the tile in the lower part of the field. At about 10 inches was discovered an almost impenetrable layer of hardpan, 9 inches thick. Trees on this site are first flooded in spring and later prevented from reaching whatever water may be present in the lower levels. No hardpan exists on the higher ground. It is also possible that the saturated condition of soil in the low area may result in leaching of nutrient elements. An analysis made by the Soils Section of the Michigan Agricultural Experiment Station shows that the higher ground possesses more potassium, phosphorus, and iron, than the lower ground. According to Dr. C. E. Millar, the higher ground is a better soil from a nutritional standpoint than the lower ground.

In all the plantations a very slight difference in elevation was found to make a very great difference in survival. The upper 6 inches of soil was almost powder dry in the summer of 1936, and the roots of almost all the 435 dead trees classified under choice of site, were found in this upper layer. The roots were confined to this region because of improper selection of planting site.

Poor Planting and Double Planting

It is impossible to place transplant roots in a normal perpendicular plane when the tree is hastily jammed into the ground. Growth increases the distortion and leads to the condition known to foresters as "U-roots" (Fig. 1). When roots are originally placed in a position

where the ends are bent up near the surface, some years must elapse before they can re-orient themselves and grow downward. Before this occurs the tree will often die for lack of moisture in the arid upper layers. Figure 2 shows a White pine typical of such cases. Some of the roots were almost protruding from the soil and many were within a half inch of the surface. The ground line may be noticed on the tree, showing the roots to be so near the surface that they would be subject to exceedingly high soil temperatures, as well as lack of moisture.

Other planting practices contributing to the mortality of the trees are: setting the plants too deep, too shallow, on a slant, or two in a hole. In 9 examples of this last condition, 16 of the 18 trees were dead. Such improper planting methods are all attributable to haste, with too much emphasis on the planting cost per acre, instead of survival per acre. One condition was found to hold throughout the investigation; trees which had made good growth the first two years after transplanting, survived in almost every instance. Whether due to improper planting, choice of site, or other reason, those trees which grew but little in the first two years, died later.

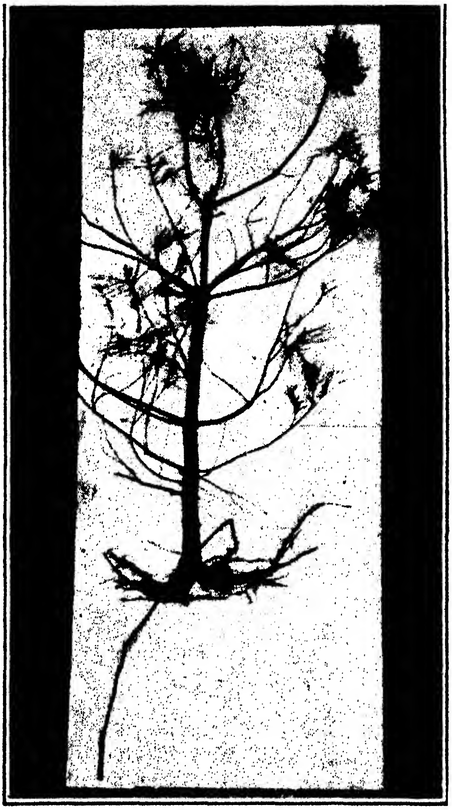

Fig. 2. White pine which died after 7 years in plantation, due to hasty planting.

Rabbit Girdle

The heavy, scaly bark of Red pine, and the rough bark of Norway spruce armored with stout needles, proved less attractive than the soft unarmored bark of White pine. It was noticed that most rabbit damage occurred on the fringes of the plantations and there was no uniform attacking of trees throughout the plantings. This would seem to indicate that conifer bark is not a preferred food but that rabbits merely turn to it when other browse is not available. Much rabbit girdling was done at some distance above the ground, at a time when, perhaps, small herbaceous material was snow-covered.

Rabbits are responsible for another type of damage which does not kill, but deforms the tree. Individuals will work down a single row and nip off lateral branches or terminals of many trees.

Heat Girdle

Trees with vitality weakened by a combination of other causes were particularly subject to heat injury in 1936. Even those planted on sites where the roots were not forced into shallow ground, showed a loss due to heat. This was evident in a lesion around the stem near the ground line. The entire phloem layer was turned into a soft pulpy mass, bulging out from the xylem beneath. Trees which had been carelessly planted most frequently succumbed to heat, although girdling was found on trees which seemed to be entirely healthy in other respects. Of the total amount of heat girdling observed, both as a primary and as a contributing factor in the death of the trees, Red pine suffered the least.

Mechanical Damage

An unexpected source of loss was found in the White pine plantation. In one place trees had been planted in uniform rows which crossed an old road leading to a fishing hole on a river. People who had been fishing the river for years felt that their rights were infringed upon and they continued to drive the road, breaking off 19 trees in 1936. This loss might be classed under choice of site, since a broad forest management policy would include recreational management and not aim at timber production to the exclusion of all other forest uses.

Freezing

Norway spruce was found to produce extremely succulent tips. In 1933, as late as the middle of June a heavy frost killed back all of the new growth. In an adjoining White pine plantation, trees were unharmed. In 1936, 13 trees were found which had been frozen back several times, and finally died. The succulence of the tips is also shown by the withering and curling of the new growth in the heat of summer. Apparently the tree is unable to furnish enough moisture to keep the tips alive. At first it was thought that the atrophied branchlets were produced by some insect, but a thorough examination uncovered no supporting evidence. On the contrary, the same withering and curling may be seen in coniferous nurseries where the stock has been accidentally deprived of water.

Snow Damage

Snow damage was observed only on Red pine. In the plantations investigated, White pine and Norway spruce branches did not bear very heavy foliage whereas the Red pine branches were bushy with leaves. Such branches not only hold a greater weight of snow, but offer more wind resistance, increasing the breakage. Red pine also produces larger branches at the base of the trees and these were considerably damaged by the settling of crusted snow.

Insect Damage

Insect damage to the Red pine was negligible. Of the 12,700 trees examined, only one was found to be seriously affected; the injury in

this case was due apparently to a species of saw fly. Another type of injury which may be due to insect attack, was the breaking and bending over of one or more laterals in the first whorl below the terminal. This may be due to mechanical action of wind or snow, but the branches pointed in all directions, denying a strong prevailing wind; they were merely bent over at the base, not exhibiting any tearing of the bark commonly associated with snow damage. No definite evidence of insect infestation was discovered, but until more information is available about this type of injury it remains a possibility. Scots pine was observed to be similarly affected, but no damage of this type was discovered in White pine or Norway spruce.

White pine was heavily infested by the weevil, *Pissodes strobi.* This was not unexpected for adjacent native White pine shows weevil injury 50 or more years back. Under cover, White pine resists weevil attack, but the area planted to White pine was formerly a field and provided no brushy cover. Only three cases were found where weevils had obviously killed trees by persistent infestation, but in a number of cases it was undoubtedly a contributing factor. Of 8,200 White pine tallied, about 3,600 were affected in some degree by weevils.

Four Norway spruce showed signs of burrowing insects sufficiently active in the main stem to cause the death of the tree. The injury was similar to that of the White pine weevil, but close examination of the affected wood did not reveal any insects which might have been responsible.

Unknown

In all the plantations there were some trees which were killed by causes unknown. White pine was especially puzzling in this respect, about 200 per cent of those trees dying for no apparent reason. Their growth had been continuous and fairly rapid, the roots were in fairly good condition, and an exploration of the surrounding soil gave no clues. Some of the pine were slightly weeviled, others were not; the infestation seemed to make no difference in those cases.

Pathology

No evidence of disease was found in any of the plantations. Weaker trees are rapidly being killed by the causes listed in Table 2, and those remaining are for the most part growing thriftily. The plantings were made at 6 x 6 or 6 x 8 spacing and the crowns have just begun to close in a few instances, so there is no crowding or stagnation.

Conclusion

In plantations of Red pine, White pine, and Norway spruce in northern Michigan, 25,000 trees now remain of the 53,700 originally planted (Table 1). In 1936, 152 trees (including 50 with mortality unknown) died from natural causes; while 690 died from causes attributable to man (Table 2). The survey indicates that unwise selection of site, and lack of care in planting, are responsible for the greatest losses.

NURSERY ROOT PRUNER FOR USE IN LIGHT SOILS

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The soil in the Dunbar nursery near Sault Ste. Marie is classified "Shelldrake Sand," a light sandy soil. It contains very few rocks and little vegetative debris and so the passage of a thin blade through the soil is hampered only slightly by extraneous materials.

The root pruners used in Forest Service nurseries are generally of such substantial construction that a tractor with winch is required to pull them. No such equipment is available at the Dunbar Nursery and it was necessary to develop a light pruner which could be pulled by a

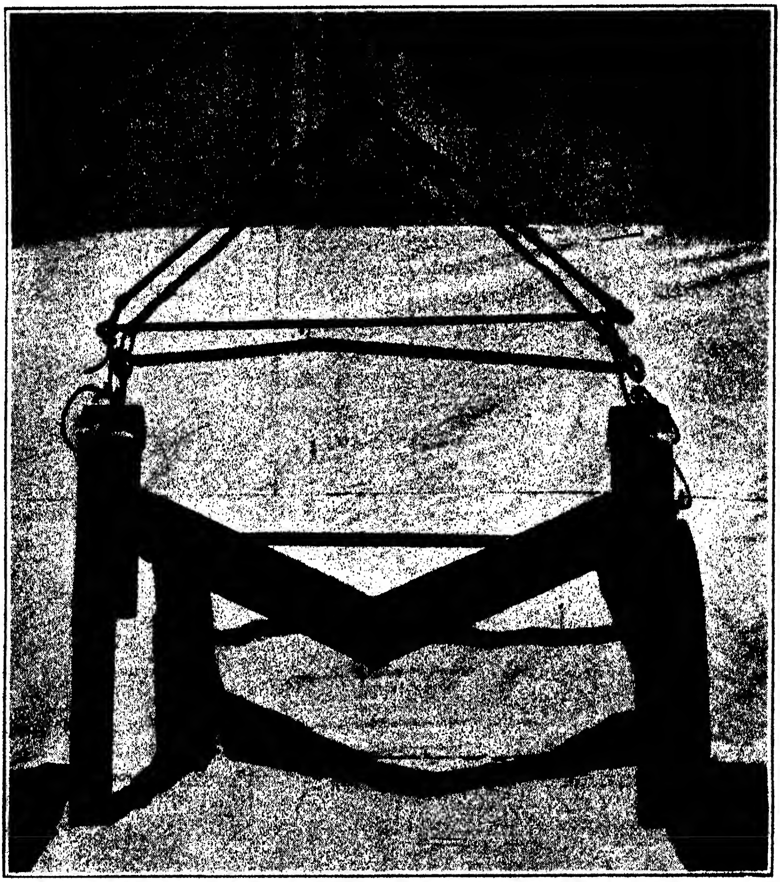

Fig. 1. A nursery root pruner for use in light soil.

small truck. As finally constructed, this device is essentially a flat V-shaped blade mounted horizontally between two flat steel skids (Figure 1). The inner sides of the V are sharpened, and the device is operated with this open side ahead. Numerous tests showed that it would dive if run with the point ahead, although this latter method would be preferable because in such position the pruner would be more or less self-cleaning. As it is, after moving about 200 feet, a certain amount of root ends and other materials accumulate on the blade and thicken it sufficiently to reduce its effectiveness. It is then necessary to stop and reach in under the seed bed with a spade, to clean off the cutting edge. This is done so readily that the accumulation of debris is not a serious fault. After some experimenting it was discovered that a scalloped edge on the blade reduced the amount of accumulation.

The pruner is drawn behind a 1½ ton truck which straddles the seed beds. To assure a straight haul, a wire rope bridle is run from the front end of the skids, and is spread with a piece of ¾″ round iron to the width of the bed. A second piece of round iron is bowed in from the spreader to a trailer hitch on the truck. The skids supporting the blade were 21 inches long. It was found that such a short bearing surface made the pruner run erratically and the skids were lengthened by bolting on hardwood extensions. If the ground is uneven, a man may ride on each skid, and by shifting weight ahead or back, counteract any tendency of the pruner to dig in, or to come out of the ground.

Depth of pruning is regulated by raising or lowering the blade where it is attached to the angle irons bolted to the skids. The turned-up ends of the blade are 16 inches high, drilled with a series of bolt holes permitting the blade to be set deeply enough to act as a seedling lifter. Holes are drilled in the blade so that steel spokes may be attached to break up the ground in lifting operations. In all places where bolt heads come in contact with the ground, holes are countersunk and flat head bolts are used to reduce friction.

Dimensions are:

Thickness of blade	1/4″
Width of blade	6″
Angle at center of blade	132°
Distance between skids	50″
Thickness of skids	1/4″
Width of skids	6″
**Length (wood and iron)*	42″
Length of angle iron bolted to skids	12″
Thickness of angle iron bolted to skids	5/16″
Weight of pruner	135 lbs.

Materials and labor in making the pruner, including welding, cost $14. Even without the added utility of using the pruner as a seedling lifter, its cost is well justified. In root pruning by hand, two men will cover about 1,500 feet of seed bed per day. Using the power-drawn device, three men will do better than a mile an hour. Although not on a comparable basis, these figures will serve as a rough comparison of the two methods.

*An additional 13″ is curved up in a 180-degree arc at front, like a sled runner.

HOPPER-FEEDING GRAIN TO LAYING PULLETS

A Comparison of Continuous Hopper Feeding of Grain With Daily Hand Feeding

J. A. DAVIDSON
SECTION OF POULTRY HUSBANDRY

The problem of obtaining satisfactory egg production from the poultry flock is important to the farmer and poultryman. It involves many details such as breeding, housing, feeding and disease control. Feeds are important since they are the source of the raw material for the egg and maintenance of the bird. Methods of feeding are not as important as the feeds. However, the question of an adequate supply of food for the various requirements of the laying bird may depend on the method of feeding.

The common practice for many years has been to hopper-feed a laying mash and scatter the scratch grain in the litter or feed it in troughs. The recommendation as to the amount of grain to feed has been to give the birds all they can eat when fed in the afternoon to a definite recommendation of from 10 to 14 pounds of grain per 100 birds daily. The recommendation for laying mashes has been to use an 18 to 20 per cent protein (crude) mash, with little thought toward the efficiency of the protein (that is, the source or type). It has been demonstrated that this method of feeding will produce satisfactory results where interruptions in the feeding schedule do not occur and careful attention is given the flock by a caretaker with a reasonable amount of experience.

The usual system of feeding is based on the assumption that the bird is incapable of taking care of its own requirements. The use of the all-mash system was at one time thought to be a satisfactory way of caring for that condition, but Graham[1] in 1934 and Kennard and Chamberlin[2] 1934, found that the individual requirements of birds vary considerable even at the same rate of production. Therefore, under the all-mash system there is not sufficient opportunity for the birds to obtain their individual requirements. Graham[1] in 1934 reported satisfactory egg production in the Massachusetts State College flock of Rhode Island Reds when corn and oats along with mash were kept in open feeders before the birds all the time. The crude protein intake was 12.9 per cent which is lower than the amount usually thought to be necessary in all mash feeding.

Satisfactory results were secured in 1934-'35 on White Leghorn

[1]Graham, J. C. "Individuality of Pullets in Balancing the Ration." Poultry Science, 18: 34-39. 1934.

[2]Kennard, D. C. and Chamberlin, V. D. Studies of Individual Layers. Ohio Exp. Sta. Bi-monthly bul. 170-186. 1934.

and Rhode Island Red pullets at this Station, a report of which may be found in the Station Quarterly Bulletin, Vol. 19, No. 1, August, 1936. However, no comparison was made with litter feeding and only corn and oats was used.

Use of Corn, Wheat, and Oats

In the fall of 1936 trials were started to compare the results of continuous hopper feeding of corn, wheat, and oats with litter feeding. Rhode Island Red pullets, February and March hatched, and White Leghorn pullets, March hatched, were used. One hundred birds were placed in 20 x 20 feet pens. The Leghorn trial covered 10 months from Oct. 1, 1936 to July 31, 1937. The Rhode Island Red trial ran from Nov. 1, 1936 to Aug. 31, 1937.

For ease in tabulation and comparison the pens were as follows:

Pen 1—White Leghorns: Litter-fed corn and wheat. Oats in hoppers.

Pen 2—Rhode Island Reds: Litter-fed corn and wheat. Oats in hoppers.

Pen 3—White Leghorns: Continuous corn, wheat, oats in hoppers.

Pen 10—Rhode Island Reds: Continuous corn, wheat, oats in hoppers.

Table 1. Mash used (in pounds).

Ingredients	Hand-fed Pens	Continuous Hopper-fed Pens
Ground barley	27.16	26.60
Ground oats	12.61	12.35
Wheat bran	14.55	14.25
Flour middlings	14.55	14.25
Meat scrap (50%)	9.70	9.50
Dried skim milk	5.82	5.70
White fish meal (60%)	2.91	2.85
Alfalfa meal (Mich.)	8.73	8.55
Salt	.97	.95
Vitamin D supplement*	3.00	5.00

*Vitamin D supplement was reduced to 2% in both mashes May 10 when birds were allowed in runs part of the time.

The mashes used, as shown in Table 1, differ only in the amount of vitamin D supplement. These mashes were used until May 10 when the birds were allowed to range and the vitamin D supplement was reduced. The variation in the vitamin D content was made to care for the difference in grain consumed during the winter months. However, the amount of vitamin D received by the hopper-fed pens was slightly greater than in the litter-fed pens. This is one of the problems that hopper feeding creates, but a similar problem is created when the vitamin D supplement is in the mash and the birds are fed all the grain they will take in the litter.

No mineral supplement other than salt was used in the mash. Ground poultry bone and oyster shells were kept in separate hoppers.

The oats was kept in a hopper in the litter-fed pen because of the variation in quality and in the amount the birds will consume. Light oats were removed from the hoppers. The oats used was of fair quality (30-33 pounds to the bushel).

No green feed was used. A wet mash was fed to the Leghorns during December. No birds were removed except those that died. The litter-fed pen was given all the grain they would clean up in the afternoon. (4:00 p.m. feeding time). Lights were turned on at 5:00 a.m. from November 15 to March 15.

Table 2. Feed consumption and production, White Leghorns. (Ingredients shown as percentage of 100 pounds feed consumed. Percentage of production calculated on hen-day basis.)

Month	Corn and Wheat		Oats		Mash		Shell		Bone		Production	
	1*	3**	1*	3**	1*	3**	1*	3**	1*	3**	1*	3**
October.....	53.64	53.26	5.37	8.20	36.82	34.88	2.43	1.18	1.71	2.44	42.28	41.31
November...	61.84	66.54	6.50	6.39	28.67	22.76	2.48	2.10	.48	2.18	30.63	27.77
December...	49.26	72.00	6.18	4.50	41.09	20.30	.69	1.00	2.76	2.16	14.56	19.61
January....	46.42	62.00	4.79	5.25	43.94	29.53	2.73	2.55	2.09	.66	51.18	53.06
February...	53.10	63.88	5.17	4.62	37.08	26.79	3.29	2.53	1.32	2.15	62.02	63.68
March......	52.94	66.10	2.68	2.18	40.04	28.50	3.42	1.18	.89	2.00	64.56	58.79
April.......	47.32	61.30	5.91	6.33	41.02	27.41	3.68	3.24	2.05	1.70	64.09	55.59
May.......	42.56	57.58	11.31	12.27	41.94	27.42	2.94	2.10	1.23	.60	59.37	59.31
June.......	44.80	60.04	8.92	8.70	43.28	28.04	2.86	2.65	.12	.54	54.04	59.00
July........	44.50	54.86	16.44	12.17	35.34	29.27	3.40	3.00	.28	.66	53.89	56.03
Average....	49.64	62.02	7.02	6.86	39.17	27.43	2.77	2.15	1.38	1.51	48.40	48.04

*Pen 1—Hand-fed corn and wheat. Oats in hoppers.
**Pen 3—Hopper-fed corn, wheat and oats.

Table 3. Feed consumption and production, Rhode Island Reds. (Ingredient consumed shown as percentage of 100 pounds feed consumed. Percentage of production calculated on hen-day basis.)

Month	Corn and Wheat		Oats		Mash		Shell		Bone		Production	
	2*	10**	2*	10**	2*	10**	2*	10**	2*	10**	2*	10**
November...	55.14	64.66	10.58	3.82	29.36	27.94	1.65	0.00	3.25	3.56	43.12	37.45
December...	54.36	64.13	9.28	4.04	31.66	25.71	.86	2.82	3.81	3.26	34.38	33.56
January....	55.27	63.32	8.01	6.16	30.53	25.26	2.25	2.12	3.91	3.08	60.99	60.56
February....	52.06	60.85	10.76	6.60	31.72	27.19	3.21	2.40	2.23	2.93	64.30	68.08
March......	56.27	65.83	2.43	2.61	35.93	26.27	2.25	2.48	3.10	2.79	63.94	68.38
April.......	52.35	59.91	6.96	7.27	36.16	28.40	2.99	2.32	1.51	2.09	64.34	51.77
May.......	49.55	58.73	11.68	12.63	34.25	24.04	2.47	2.40	2.02	2.17	64.95	57.85
June.......	53.84	70.13	11.29	6.44	31.18	19.92	1.99	1.83	1.67	1.66	49.39	54.24
July........	54.24	64.06	16.62	9.22	26.24	22.12	1.66	2.17	1.22	1.50	30.53	50.95
August.....	53.55	61.24	15.24	9.44	25.82	25.98	2.44	1.79	2.92	1.52	35.90	44.74
Average....	53.69	63.37	9.92	6.59	31.55	25.44	2.18	2.03	2.64	2.53	51.00	52.38

*Pen 2—Hand-fed corn and wheat. Oats in hoppers.
**Pen 10—Hopper-fed corn, wheat and oats.

Results

Tables 2 and 3 give the percentages of corn and wheat, oats, mash, oyster shell, and ground bone consumed of each hundred pounds of feed used. The percentage production is also included for comparison. Table 4 gives the mortality. Table 5 shows the protein intake, cost of feed and feed cost per dozen eggs.

Discussion

The White Leghorn pullets (Table 2) produced at the same rate for the entire period. The significant point here is that during a molt in

Table 4. Mortality.

Month	Leghorns—Number Died		Rhode Island Reds—Number Died	
	Pen 1	Pen 3	Pen 2	Pen 10
October	3	1	2	0
November	5	5	7	6
December	3	2	3	3
January	5	6	0	1
February	5	6	3	3
March	3	0	0	6
April	2	2	1	1
May	3	5	1	4
June	1	0	0	1
July	3	1	1	1
August	—	—	4	2
Total	33	28	22	28
Percentage died	33%	28%	22%	28%

December the hopper-fed pen laid slightly more and during June and July they laid much more (although consuming 10 to 16 per cent more grain and consequently less mash) than the litter-fed pen. It is also significant that the amount of oats consumed was approximately the same in both cases. The corn and wheat is combined since there is a tendency for the birds to eat only wheat. Consequently by mixing the corn and wheat together in the same feeder this was counteracted to some extent. Equal parts by weight of corn and wheat were used.

The Rhode Island Red pullets showed little difference in egg production (Table 3). However, they produced eggs with less mash than the White Leghorns and consequently more grain. The hand-fed pen with oats in the hoppers ate more oats than the corresponding Leghorn pen and the hopper-fed Red pen.

The mineral requirements of Reds seem to be different from the Leghorns. The Reds require more ground bone than Leghorns while the oyster shell requirement was lower.

The mortality was similar for both varieties on each method of feeding. The mortality was high and a considerable part of this could

have been saved by culling with some salvage value. Approximately half the mortality was due to cannibalism.

The cost of producing a dozen eggs was similar on either system of feeding for both breeds.

The continuous hopper feeding of grain would seem to be the most satisfactory since it eliminates necessity for regular feeding schedules, change of caretaker upsets, and lack of sufficient grain. It complicates the problem of supplying sufficient vitamin D and requires more hopper space. Pullets, fed in this manner, should have been raised by hopper feeding during the growing period.

Table 5. Cost of Feed, feed per dozen eggs, and production.

	Pen 1	Pen 3	Pen 2	Pen 10
Average protein (crude) intake	14.17	13.49	13.79	13.47
Cost of 100 lbs. feed	2.44	2.41	2.37	2.39
Pounds of feed per bird	78.1	80.8	80.7	79.5
Dozens of eggs	1008.6	1025.7	1105.5	1105.5
Pounds of feed per dozen eggs	6.7	7.0	6.8	6.4
Cost of feed per dozen eggs	.163	.168	.160	.152
Number of eggs per bird (10 months)	147.4	146.1	155.2	159.3

FARM PRICES AND COSTS IN MICHIGAN

ORION ULREY
SECTION OF ECONOMICS

Michigan Technical Bulletin 129, "Michigan Farm Prices and Costs," which was published in 1934 traced the price situation of Michigan's agriculture from 1910 to 1934. The purpose of this study is to bring the statistical description of Michigan farm prices and costs up to date, to make corrections and additions to the original indexes of prices and costs and to describe briefly the changes in the farm price situation since 1929.

Price Index of Michigan Farm Products

A number of changes have been made in the index of prices received by Michigan farmers for the farm products which they sell since the original study. Buckwheat has been eliminated from the index, and clover seed has been added. The former is relatively unimportant, while Michigan farmers have recently sold nearly a million dollars worth of clover seed annually. Alfalfa hay has replaced "all hay" in the index. The term "all hay" includes clover, timothy, prairie, alfalfa and mixed hays. Consequently, the price does not refer to any particular type marketed. Alfalfa hay production has expanded rapidly since 1925 until it constituted about one-half of the production of all hay during 1932-36 and most of the hay that entered into commerce. The use of alfalfa hay instead of all hay reduces the importance of

hay in the feed crop index, thus increasing the relative importance of the other feed crops—corn, oats and barley.

Since the Bureau of Agricultural Economics of the United States Department of Agriculture has recently collected prices of milk received by farmers since 1910 and also collects such data currently, the state average prices have been substituted for the Detroit prices which were used in the study published in 1934. The Detroit prices include transportation costs to the city, while the average prices are for milk sold at wholesale and at the farm. A series of monthly butterfat prices has also been recently prepared by the Agricultural Statistician of Michigan for the period 1910-19; such data were not previously available. Butterfat prices have been substituted for the butter prices which were formerly used to indicate the trend of the prices of butterfat.

The annual average prices have been re-calculated on the basis of the average monthly marketings as reported in Michigan Technical

Table 1. Percentage of total value of the 20 farm products used in Michigan farm price index, (1910-14 prices, 1924-28 quantities sold.)*

Product	Per cent		Product	Per cent.	
Wheat	8.43		Cattle	7.81	
Rye	.82		Calves	3.30	
Beans	7.35		Hogs	10.00	
Potatoes	5.93		Sheep	.28	
Clover seed	.51		Lambs	2.88	
Apples	1.77		Wool	1.08	
Cash crops		24.81	Meat animals and wool		25.35
Corn	.40		Chickens	3.42	
Oats	2.27		Eggs	8.80	
Barley	.25				
Alfalfa hay	3.18		Poultry and products		12.26
Feed crops		6.10			
			Milk	17.50	
			Butterfat	13.98	
			Dairy products		31.48
			Twenty farm products		100.00

*For alfalfa hay, the quantities sold during 1932-36, or 320,000 tons were used in weighting the index. An average of 868,000 bushels of clover seed was marketed annually during 1924-28. See table 1, p. 6, Mich. Tech. Bul. 139 for quantities of other products sold annually.

Bulletin 139, table 68, page 93. Thus, the annual price is a weighted average instead of an arithmetic average as determined in the previous study. This change does not affect the index for the 20 farm products as much as the indices of groups of products and individual commodities. For example, the weighted average price of potatoes during 1910-14 was 60.8 cents a bushel, while the arithmetic average was 77.7 cents because the largest proportion of the potato crop is usually marketed during the months of low prices. The weighted average prices are consequently more representative of the price situation of farmers than are the arithmetic averages.

In preparing the index of 20 farm products, indices of each of the five groups (cash crops, feed crops, meat animals and wool, poultry

and eggs, and dairy products) were calculated prior to combining them on the basis of per cent of total values at 1910-14 prices and 1924-28 quantities sold (Table 1).

Prices of Michigan farm products declined very rapidly from an index of 165 in 1929 (1910-14 = 100) to 64 in 1932 but recover to 120 in 1936 (Table 2). Prices have more than doubled since the low months of February and March of 1933. The trend during the middle of 1937 has been slightly downward.

Table 2. Index numbers of prices of Michigan farm products, 1910-37 (1910-14 = 100). (Weighted aggregative of 20 farm products.)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Weighted Average*
1910-14	108	105	103	98	97	95	99	102	104	104	106	108	100
1924-28	161	160	155	155	153	152	154	156	154	157	162	166	154
1910	110	105	108	101	97	95	96	101	104	102	101	101	100
1911	99	94	91	85	82	81	91	97	97	98	103	106	90
1912	109	108	108	110	108	104	103	102	102	104	106	109	104
1913	109	108	98	94	96	96	98	102	105	110	111	115	102
1914	113	111	108	101	100	102	105	108	110	108	109	109	104
1915	115	114	109	106	104	102	102	101	103	109	113	119	105
1916	121	124	123	121	120	120	128	128	141	148	161	164	133
1917	170	182	189	204	215	209	195	191	192	203	202	210	191
1918	207	213	205	198	192	184	195	209	217	217	217	228	201
1919	225	223	209	221	221	212	226	240	228	225	229	236	217
1920	242	243	241	251	255	247	242	223	214	201	195	172	219
1921	164	141	142	129	118	117	128	149	147	144	145	147	135
1922	134	142	141	139	144	147	147	136	128	134	144	158	131
1923	154	150	150	145	140	135	138	144	151	148	150	149	143
1924	146	146	135	131	127	129	134	139	138	143	144	150	137
1925	157	155	154	149	148	152	154	160	154	160	175	178	153
1926	179	174	168	173	170	159	157	155	154	157	165	168	163
1927	163	160	154	153	151	158	159	157	155	160	102	165	155
1928	161	163	165	170	168	164	168	168	168	165	166	169	163
1929	169	171	171	161	161	157	160	176	171	179	176	170	165
1930	162	157	147	147	144	140	134	137	145	138	131	122	144
1931	116	109	108	109	101	96	94	96	93	88	87	83	94
1932	75	70	69	67	62	61	68	65	66	66	66	66	64
1933	62	58	58	61	70	70	90	91	91	85	86	80	73
1934	80	89	90	87	85	86	88	96	101	96	98	98	89
1935	105	111	108	111	106	101	100	104	106	108	110	113	104
1936	112	116	109	109	107	114	129	137	134	132	136	138	120
1937	141	144	144	143	138	135	135	129	127				
1938													
1939													

*The monthly prices are weighted by the percentage marketed monthly to determine the weighted average annual prices. The per cent marketed each month is shown in table 68, p. 93, Mich. Tech. Bul. 130.

General Price Level and Prices of Farm Products

During the deflation of 1929-'32, prices of farm products fell to levels considerably below the prices of all commodities but has since recovered to almost the pre-war relationship (Fig. 1). Data for previous periods of falling and rising price levels show that prices of farm products have behaved in a similar way relative to prices of all commodities.

Food Prices and Distribution Costs

The primary reason for the relatively rapid decline in farm prices during the deflation of 1929-32 was that the costs of marking farm products declined less rapidly than did retail prices of the same products. Consequently, farmers received a smaller proportion of the lower retail prices. While retail food prices declined 36 per cent from 1929 to 1932, the farm price of the same foods declined 57 per cent, mainly because the cost of getting the same foods from the farmer

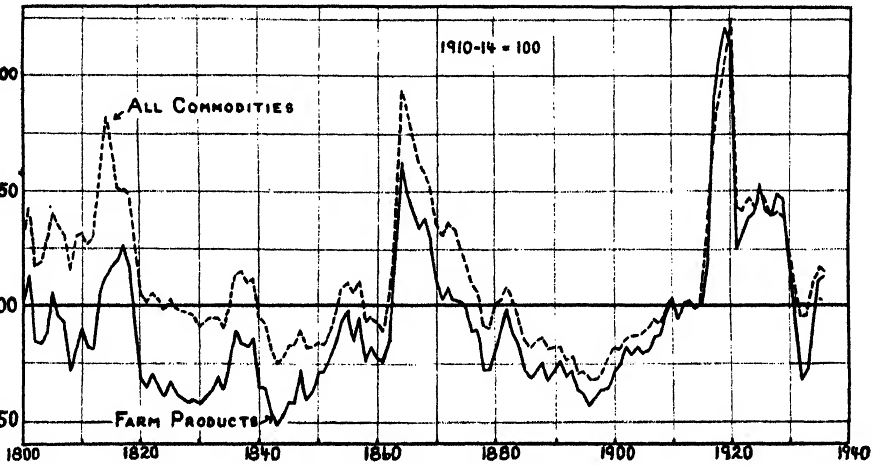

Fig. 1. Index numbers of wholesale prices of all commodities and farm products in the United States, 1800-1936.

The movement of commodity prices since 1800 has been an important factor causing changes in farm income.

Table 3. Index numbers of farm food prices, wholesale food prices, retail food prices, cost of distributing food and industrial wages in the United States, 1929-'36.*

Year	Farm food prices**	Wholesale food prices***	Retail food prices**	Distribution costs**	Industrial wages****
1910–14	100	100	100	100	100
1924–28	145	151	167	188	232
1929	151	155	174	198	242
1930	129	141	169	196	232
1931	89	116	135	178	213
1932	64	95	109	153	183
1933	68	94	106	140	176
1934	82	109	122	158	187
1935	108	130	143	174	196
1936	116	125	146	171	204
1937					
1938					
1939					

*Indexes for 1910–28 in Mich. Tech. Bul. 139, table 4, p. 14.
**Indexes of prices received for farmers for food, prices paid by farmers for the same food items, and the cost of marketing or distributing food from the farm to the consumer. Published in Farm Economics, by the Department of Agricultural Economics and Farm Management, New York State College of Agriculture.
***U. S. Bureau of Labor Statistics Index of wholesale prices of food products.
****Weekly earnings of New York factory workers.

to the consumer declined only 23 per cent (Table 3). The increase in the level of prices since 1932 has tended to improve the farm price situation. During the inflation from 1933 to 1936 the rise in retail food prices of 38 per cent was instrumental in bringing about a rise in farm food prices of 71 per cent since distribution costs rose only 18 per cent. This relationship of retail prices and distribution costs to farm prices was similar during the deflation of 1920-22 (Fig. 2). Industrial wages is one of the factors in distribution costs which also include such cost items as freight rates, rents and interest charges.

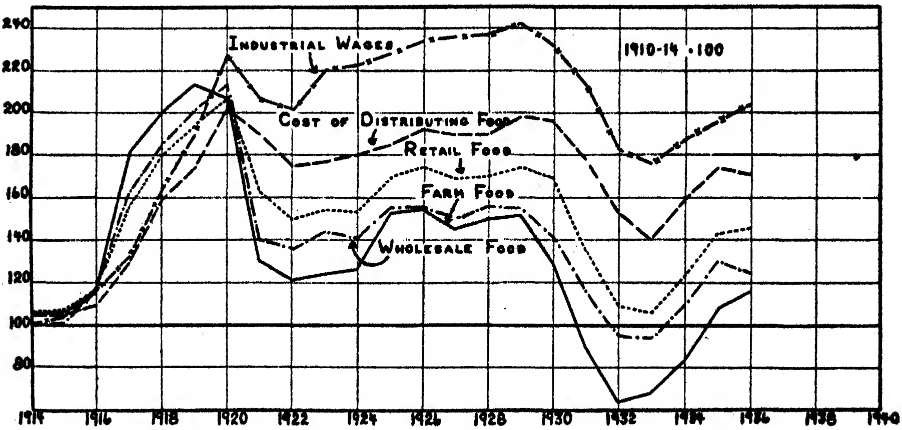

Fig. 2. Index numbers of prices paid by farmers for food, wholesale prices of food, retail prices of food, cost of distributing food and industrial wages, 1914-36.

The relatively high cost of getting the farm products from the farm to the consumer has been mainly responsible for the unfavorable farm prices since deflation began in 1920.

Michigan Farm Prices and Other Prices

The indexes of prices paid by farmers of the United States for commodities bought are used for Michigan (Table 4). Although the prices of such commodities as feeds and seeds in Michigan may vary considerably from the United States averages, the composite price indices of commodities used in production and of commodities used in family living for the United States as a whole are probably satisfactory for comparison with Michigan farm prices.

The prices of things which farmers bought did not decline so rapidly as the prices of the products which farmers sold during the deflation of 1929-32 (Table 5). The buying power of farm products in Michigan in terms of commodities bought declined from a favorable index of 108 in 1929 (compared with 1910-14 as 100) to an unfavorable index of 60 in 1932. With the recovery of prices during 1933-36, the ratio of prices received to prices paid rose to 97 per cent of the pre-war condition. Farm prices in Michigan have been relatively more favorable than for the United States as a whole since the war period.

Farm wages in Michigan dropped low during the severe unemployment period of the depression (Table 6). With the improvement in

business conditions and commodity prices, farm wages rose steadily and were twice as high in October 1937 as four years earlier.

Farm taxes and farm interest payments were materially reduced from 1932 to 1936 until they were relatively lower than Michigan farm prices (Table 7 and Fig. 3). The adoption of the amendment limiting taxes to 1½ per cent of the assessed valuation of real estates, the payments on local governmental debts previously contracted, and general retrenchment in expenses of local governments have been pri-

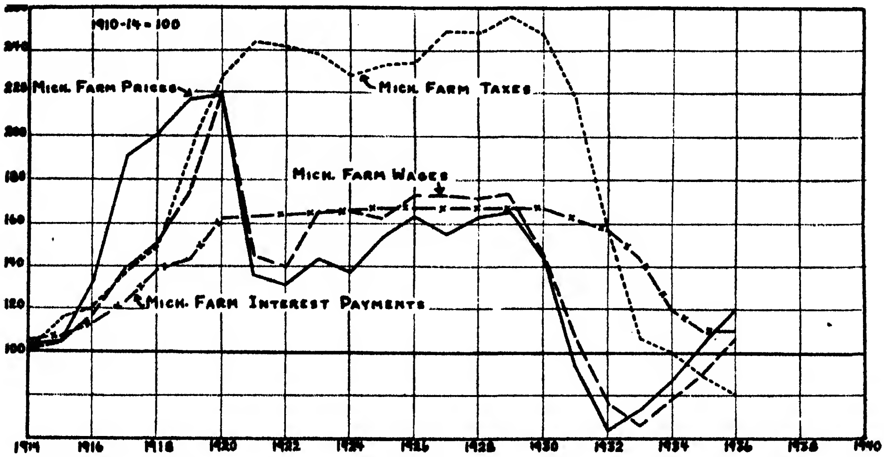

Fig. 3. Index numbers of Michigan farm prices, taxes, wages and interest payments, 1914-36.

Farm taxes and interest payments reached such levels that they were not a burden to farmers by 1936. Although farm wages declined to very low levels in 1933, they have been rising and probably will increase more rapidly than farm prices with continued business recovery.

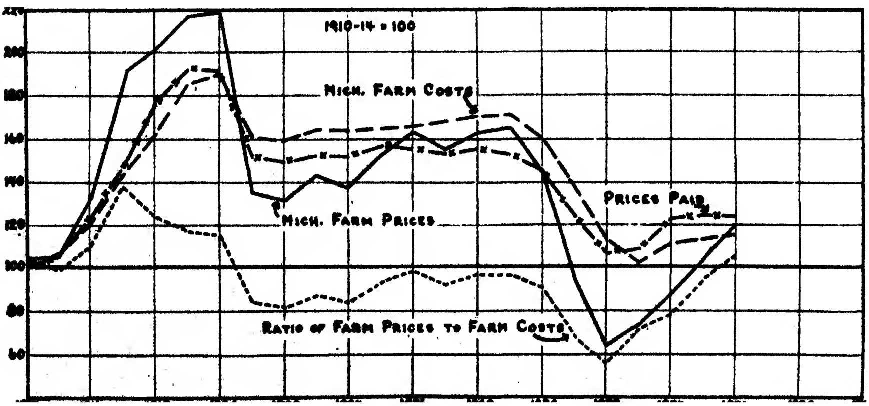

Fig. 4. Index numbers of Michigan farm prices, prices paid for commodities bought, farm costs, and the ratio of farm prices to farm costs, 1914-36.

Farm prices were relatively unfavorable to farm costs after the deflation in 1920 until 1936.

Table 4. Index numbers of prices paid farmers for commodities bought to be used in production and in family living in the United States, 1929-37.*

Year and month	Feed	Farm machinery	Fertilizer	Bldg. material other than for house	Equipment and supplies	Seed	All commodities used in production	Food	Clothing	Operating expenses	Furniture and furnishings	Bldg. materials—house	All commodities used in family living	Combined production and living
1910–14	100	100	100	100	100	100	100	100	100	100	100	100	100	100
1924–28	141	153	125	161	139	183	146	153	181	129	193	171	161	154
1929	145	153	130	159	136	185	147	149	177	127	188	170	158	153
1930	132	152	126	155	131	174	140	137	167	122	179	166	148	145
1931	93	150	115	139	116	152	122	109	142	110	153	149	126	124
1932	69	141	99	126	107	102	107	90	115	103	128	134	108	107
1933	79	137	96	129	103	95	108	95	114	102	126	138	109	109
1934	110	144	104	146	109	140	125	108	131	106	136	155	122	123
1935	111	148	102	145	108	154	126	120	126	106	136	153	124	125
1936	115	149	96	146	110	141	126	116	125	106	135	154	123	124
1937														
1938														
1939														
1929—December	142	154	129	159	135	185	146	147	177	128	188	170	157	152
1930—March	134	154	126	158	133	176	142	146	174	125	186	170	155	150
June	135	152	126	157	132	176	142	144	168	124	184	168	152	148
September	138	152	125	153	131	176	142	135	164	122	174	163	146	144
December	120	152	125	150	128	168	135	123	160	119	171	161	140	138
1931—March	108	151	119	144	124	174	129	117	153	115	162	155	134	132
June	100	150	119	140	114	174	125	114	145	110	157	151	129	127
September	83	150	110	137	114	133	117	106	139	107	149	147	124	121
December	80	148	110	134	114	127	116	99	132	107	143	143	118	117
1932—March	76	144	103	130	111	109	112	94	124	104	136	139	113	112
June	72	142	103	127	106	109	109	90	116	104	129	136	108	108
September	67	140	96	124	106	94	105	91	111	103	125	131	106	106
December	62	139	96	123	104	94	104	85	108	101	122	131	103	103
1933—March	62	135	91	119	100	85	101	83	102	98	117	126	99	100
June	77	135	91	122	97	85	104	92	102	96	120	130	102	103
September	90	139	99	136	106	111	114	104	125	105	132	145	117	116
December	86	140	102	140	108	111	114	100	128	107	134	150	117	116

Table 4. Continued.

Year and month	Feed	Farm machinery	Fertilizer	Bldg. material other than for house	Equipment and supplies	Seed	All commodities used in production	Food	Clothing	Operating expenses	Furniture and furnishings	Bldg. materials —house	All commodities used in family living	Combined production and living
1934—March	91	142	104	148	108	119	119	104	132	107	135	157	121	120
June	97	144	104	149	110	115	121	107	131	107	135	158	122	121
September	122	146	105	145	109	162	129	113	130	106	137	153	123	126
December	132	146	105	144	110	162	131	110	130	106	137	152	122	126
1935—March	128	148	106	143	109	190	131	118	128	106	137	151	124	127
June	122	148	106	145	108	190	130	121	124	106	136	153	124	127
September	102	149	99	146	108	118	122	120	125	106	136	154	124	123
December	93	148	99	145	109	118	119	120	126	107	135	152	124	122
1936—March	94	148	95	145	109	125	119	114	124	107	135	153	122	121
June	94	149	95	147	109	125	120	114	123	104	134	154	121	120
September	136	149	96	146	110	158	132	119	125	106	133	153	123	127
December	137	149	96	147	111	158	134	117	128	107	136	155	124	128
1937—March	144	151	102	155	113	212	139	121	131	109	140	164	127	132
June	147	153	102	157	115	212	141	124	131	109	142	165	129	134
September	117		102			172								130
December														
1938—March														
June														
September														
December														
1939—March														
June														
September														
December														

*Indices for 1910–'28 in Mich. Tech. Bul. 139, table 5, p.17. A few changes have been made in the indices since the previous study was published.

Table 5. Index numbers of Michigan farm prices, United States farm prices, prices paid by farmers for commodities bought, ratio of prices received to prices paid for Michigan and for the United States, 1910-37.*

Year and month	Michigan farm prices	U. S. farm prices	Prices paid by farmers	Ratio of prices received to prices paid**	
				Michigan	U. S.
1910–14	100	100	100	100	100
1924–28	154	146	154	100	95
1910	100	102	98	102	104
1911	90	95	101	89	94
1912	104	100	100	104	100
1913	102	101	101	101	100
1914	104	101	100	104	101
1915	105	98	105	100	93
1916	133	118	124	107	95
1917	191	175	149	128	117
1918	201	202	176	114	115
1919	217	213	202	107	105
1920	219	211	201	109	105
1921	135	125	152	89	82
1922	131	132	149	88	89
1923	143	142	152	94	93
1924	137	143	152	90	94
1925	153	156	157	97	99
1926	163	145	155	105	94
1927	155	139	153	101	91
1928	163	149	155	105	96
1929	165	146	153	108	95
1930	144	126	145	99	87
1931	94	85	124	76	70
1932	64	65	107	60	61
1933	73	70	109	67	64
1934	89	90	123	72	73
1935	104	108	125	83	86
1936	120	114	124	97	92
1937					
1938					
1939					
1929—December	170	147	152	112	97
1930—March	147	135	150	98	90
June	140	131	148	95	89
September	145	120	144	101	83
December	122	104	138	88	75
1931—March	108	97	132	82	73
June	96	86	127	76	68
September	93	80	121	77	66
December	83	75	117	71	64
1932—March	69	69	112	62	62
June	61	58	108	56	54
September	66	66	106	62	62
December	66	63	103	64	61
1933—March	58	55	100	58	55
June	70	71	103	67	69
September	91	80	116	78	69
December	80	78	116	69	67
1934—March	90	84	120	75	70
June	86	85	121	71	70
September	101	103	126	80	82
December	98	101	126	78	80
1935—March	108	108	127	85	85
June	101	104	127	80	82
September	106	107	123	86	87
December	113	110	122	93	90
1936—March	109	104	121	97	86
June	114	107	120	95	89
September	134	124	127	106	98
December	138	126	128	108	98
1937—March	144	128	132	109	97
June	135	124	134	101	93
September	127	118	130	98	91
December					
1938—March					
June					
September					
December					
1939—March					
June					
September					
December					

*To replace table 6, p. 19, Mich. Tech. Bul. 139.
**Frequently called the index of buying power of farm products. Calculated by dividing the indexes of farm prices by the index of prices paid by farmers.

marily responsible for the reduction of real estate taxes to very low levels in most farm communities. The adjustments of debts downward, the payments on debts, and the lowering of interest rates decreased annual interest payments about 30 per cent from 1930 to 1935.

The comparison of the indexes of farm prices to farm costs is of more significance than to prices paid for commodities bought because the farm costs index includes taxes, wages and interest pay-

Table 6. Monthly wages paid Michigan farm laborers and index numbers of Michigan farm wages, 1910-37* (March, 1910-14 = 100).

Year and month	Weighted wages	Index numbers	Year and month	Weighted wages	Index numbers	Year and month	Weighted wages	Index numbers
1910–14	$28.18	100	1932—Jan.	$22.60	80	1937—Jan.	$28.90	103
1924–28	47.86	170	Apr.	24.25	86	Apr.	30.15	107
1929	49.01	174	July	22.15	79	July	39.45	140
1930	41.16	146	Oct.	20.75	74	Oct.	39.45	140
1931	30.28	107	1933—Jan.	17.60	62	1938—Jan.		
1932	21.74	77	Apr.	17.60	62	Apr.		
1933	18.84	66	July	19.15	68	July		
1934	21.91	78	Oct.	19.95	71	Oct.		
1935	25.70	90	1934—Jan.	18.30	65	1939—Jan.		
1936	29.98	107	Apr.	22.35	79	Apr.		
1937			July	22.60	80	July		
1938			Oct.	22.75	81	Oct.		
1939			1935—Jan.	20.10	71			
1929—Oct.	48.94	174	Apr.	25.05	89			
1930—Jan.	45.70	162	July	25.95	92			
Apr.	45.30	161	Oct.	26.60	94			
July	42.40	150	1936—Jan.	25.10	89			
Oct.	38.60	137	Apr.	28.70	102			
1931—Jan.	32.30	115	July	30.30	108			
Apr.	34.10	121	Oct.	32.50	115			
July	31.20	111						
Oct.	28.70	102						

*Indexes for 1910–28 in Mich. Tech. Bul. 139, table 7, p. 22.

Table 7. Michigan farm real estate tax per acre and index numbers of farm prices, farm wages, farm real estate taxes, farm mortgage interest payments, and farm real estate values per acre, 1929-36.*

Year	Farm prices	Farm wages	Real estate taxes		Farm interest payments	Farm real estate values
			Tax per acre	Index number		
1910–14	100	100	$0.54	100**	100	100***
1924–28	154	170	1.29	238	167	131
1929	165	174	1.38	256	167	124
1930	144	146	1.34	247	167	121
1931	94	107	1.18	218	162	115
1932	64	77	.85	158	157	97
1933	73	66	.58	107	144	80
1934	89	78	.54	100	120	82
1935	104	90	.48	89	110	83
1936	120	107	.44	81	110	84
1937						
1938						
1939						

*Indices for 1910–28 in Mich. Tech. Bul. 139, table 8, p. 24.
**1913 = 100.
***1912–14 = 100.

ments as well as commodities used in farm production. Farm costs were relatively higher than farm prices in Michigan during 1921-35 primarily because of high taxes and wages during most of the period (Table 8 and Fig. 4). After the rise in farm prices during 1933-36, farm prices were favorable to farm costs compared with the pre-war period. The ratio of farm prices to farm costs presents in a reasonable satisfactory manner the relative price position of Michigan farm products.

Table 8. Index numbers of prices of Michigan farm products, Michigan farm costs and ratio of farm prices to farm costs, 1910-36.*

Year	Farm prices	Farm costs**	Ratio of farm prices to farm costs	Year	Farm prices	Farm costs	Ratio of farm prices to farm costs
1910–14	100	100	100	1924	137	164	84
1924–28	154	167	92	1925	153	165	93
1910	100	98	102	1926	163	166	98
1911	90	101	89	1927	155	168	92
1912	104	99	105	1928	163	170	96
1913	102	101	101	1929	165	171	96
1914	104	100	104	1930	144	160	90
1915	105	106	99	1931	94	138	68
1916	133	121	110	1932	64	114	56
1917	191	144	138	1933	73	103	71
1918	201	162	124	1934	89	111	80
1919	217	185	117	1935	104	111	94
1920	219	190	115	1936	120	113	106
1921	135	161	84	1937			
1922	131	159	82	1938			
1923	143	164	87	1939			

*To replace table 9, p. 28, Mich. Tech. Bul. 139.
**The index of farm costs was constructed by combining the indices of prices paid for commodities used in production (466), farm taxes (140), farm wages (150), and farm interest payments (85).

PRICES OF GROUPS OF FARM PRODUCTS

Although the prices of all the groups of farm products declined during 1929-32, cash and feed crops fell to the lowest levels (Tables 9-13). The recovery during 1933-36 brought a more rapid advance in the prices of livestock and their products than in cash and feed crops. Prices of livestock and their products, except for the drouth year of 1934, have continued to remain relatively favorable to prices of feed crops.

Table 9. Index numbers of farm prices of Michigan cash crops, 1910-37* (1910-14 = 100) (wheat, rye, beans, potatoes, apples, clover seed).

Year	January	February	March	April	May	June	July	August	September	October	November	December	Weighted average
1910–14	101	102	102	103	105	105	112	113	106	98	96	99	100
1924–28	166	168	167	174	178	177	176	175	151	151	160	165	163
1910	100	100	97	89	89	90	97	109	108	97	91	92	96
1911	93	91	91	94	94	89	117	126	112	102	106	112	96
1912	118	123	131	139	143	142	134	120	106	98	95	94	116
1913	96	96	92	90	95	95	98	100	96	98	98	99	95
1914	100	101	100	102	106	111	113	112	109	96	94	99	98
1915	112	124	120	120	122	116	114	109	108	116	122	135	116
1916	146	151	148	149	152	159	185	190	205	211	242	246	185
1917	255	281	309	350	403	385	305	278	251	274	271	256	301
1918	257	258	252	241	230	218	235	261	249	236	220	218	232
1919	220	207	210	229	237	235	256	274	255	234	235	249	229
1920	272	292	303	346	392	383	351	279	214	180	165	151	256
1921	146	139	132	111	114	111	136	180	183	161	151	150	142
1922	151	167	177	179	193	206	201	164	119	118	128	138	134
1923	150	152	150	157	155	149	151	158	153	136	127	123	139
1924	126	126	123	122	120	130	144	155	136	138	137	138	130
1925	159	168	158	150	160	171	161	180	150	158	200	208	161
1926	227	219	213	238	231	182	176	168	150	147	161	158	190
1927	157	152	142	141	162	208	206	189	160	155	156	159	162
1928	158	174	198	219	217	194	192	183	161	156	158	163	174
1929	166	178	172	160	159	159	162	218	203	213	207	190	179
1930	188	185	171	171	178	179	165	164	168	146	129	122	162
1931	121	119	114	118	115	114	104	96	75	58	64	60	87
1932	56	56	57	57	55	56	68	51	52	49	44	43	51
1933	46	47	50	62	77	74	115	132	121	88	88	89	76
1934	99	111	108	102	100	103	102	108	113	91	85	88	99
1935	90	89	89	93	89	89	86	86	80	81	80	82	79
1936	85	89	88	93	100	124	160	172	155	147	152	163	126
1937	177	198	191	188	177	179	164	127	103				
1938													
1939													

*To replace table 10, p. 30, Mich. Tech. Bul. 139

Table 10. Index numbers of farm prices of Michigan feed crops, 1910-37* (1910-14 = 100) (corn, oats, barley, alfalfa hay).

Year	January	February	March	April	May	June	July	August	September	October	November	December	Weighted average
1910–14	97	99	100	102	105	107	106	102	99	99	98	98	100
1924–28	115	116	115	112	116	120	118	113	106	108	108	111	110
1910	110	115	117	115	111	111	108	104	99	94	89	84	103
1911	80	78	79	81	84	93	96	95	100	106	111	113	95
1912	115	120	124	131	139	136	132	110	90	88	86	85	109
1913	85	83	81	83	88	94	98	99	101	100	97	98	92
1914	97	97	99	99	103	101	98	101	106	109	108	110	102
1915	103	108	108	107	113	107	108	102	94	89	91	91	100
1916	85	100	101	98	102	99	91	90	91	95	101	105	99
1917	104	113	113	128	143	152	146	140	127	137	154	167	133
1918	180	189	205	192	183	167	162	158	166	180	185	187	173
1919	173	167	169	181	203	204	184	207	177	183	185	191	185
1920	205	207	212	222	240	245	228	200	181	153	139	132	188
1921	124	114	106	96	96	94	100	98	105	106	101	100	102
1922	96	97	108	110	105	109	91	87	84	85	91	96	96
1923	99	96	96	100	99	99	97	91	99	99	110	116	99
1924	118	120	121	125	123	125	129	128	117	115	110	111	118
1925	117	114	106	96	96	103	114	120	110	111	114	119	107
1926	118	122	120	113	121	122	110	106	99	104	107	110	114
1927	112	112	111	109	111	114	112	104	102	105	104	107	109
1928	108	111	114	119	128	134	129	105	101	103	103	106	110
1929	108	115	115	110	108	109	106	101	102	107	106	106	109
1930	106	106	104	107	106	102	93	101	117	119	116	115	106
1931	112	106	102	101	100	91	78	70	67	65	67	68	88
1932	64	62	60	60	59	56	51	48	47	45	43	41	53
1933	41	41	42	47	54	55	70	66	66	64	66	66	56
1934	71	76	81	86	89	99	105	127	137	135	129	132	101
1935	129	131	126	122	116	107	75	61	60	61	56	56	95
1936	57	59	56	57	57	61	74	92	96	96	98	102	76
1937	108	111	109	111	114	108	96	73	76				
1938													
1939													

*To replace table 11, p. 31, Mich. Tech. Bul. 139.

Table 11. Index numbers of farm prices of Michigan meat animals and wool, 1910-37* (1910-14 = 100), (cattle, calves, hogs, sheep, lambs, wool).

Year	January	February	March	April	May	June	July	August	September	October	November	December	Weighted average
1910–14	99	99	98	99	103	102	101	103	104	101	97	95	100
1924–28	141	145	146	149	147	147	149	152	155	154	147	146	149
1910	107	102	114	109	117	108	104	102	104	99	96	92	103
1911	94	91	91	87	81	82	84	87	89	83	88	80	85
1912	83	84	87	94	99	97	93	98	101	102	95	95	94
1913	100	103	85	90	107	111	110	112	109	110	106	105	108
1914	110	113	114	114	112	112	116	117	116	110	100	100	110
1915	102	101	104	106	107	108	107	105	106	107	101	97	104
1916	103	115	121	123	127	127	126	124	128	121	121	124	121
1917	134	150	165	181	182	181	181	181	190	197	180	188	176
1918	192	193	196	203	207	207	209	210	213	207	199	199	199
1919	203	203	214	227	223	220	235	232	207	189	183	181	205
1920	191	199	199	202	194	183	182	178	182	177	158	130	179
1921	128	121	128	118	112	110	115	118	111	102	100	103	113
1922	107	121	129	126	132	134	132	127	126	127	122	123	124
1923	125	129	129	124	122	122	121	123	131	125	117	113	124
1924	117	110	120	123	123	119	115	123	123	133	128	129	128
1925	137	142	161	153	147	147	156	154	157	152	147	150	149
1926	156	160	153	157	156	162	164	156	160	159	153	151	156
1927	149	155	156	157	150	144	142	149	152	156	147	144	150
1928	145	150	152	153	161	164	170	176	185	171	161	156	161
1929	160	165	171	171	175	169	173	170	161	159	149	151	163
1930	154	156	153	145	137	138	125	123	126	120	116	109	133
1931	112	108	106	107	101	93	93	94	91	84	76	71	93
1932	70	69	70	69	60	59	71	70	68	62	58	56	64
1933	55	59	59	57	66	70	71	70	70	71	65	59	61
1934	65	75	75	71	70	68	71	72	82	78	72	73	72
1935	94	103	115	115	118	120	118	128	131	129	123	125	118
1936	128	129	126	127	123	126	125	129	129	124	120	125	126
1937	135	131	134	136	137	142	144	156	153				
1938													
1939													

*To replace table 12, p. 32, Mich. Tech. Bul. 32.

Table 12. Index numbers of farm prices of Michigan poultry products, 1910-37*
(1910-14 = 100) (chickens, eggs).

Year	January	February	March	April	May	June	July	August	September	October	November	December	Weighted average
1910-14	127	119	104	92	92	93	94	97	106	112	120	128	100
1924-28	199	178	143	143	145	144	148	156	169	183	213	224	156
1910	134	125	108	101	101	101	98	101	108	113	119	125	105
1911	119	101	84	81	81	81	84	84	91	103	108	114	84
1912	130	132	112	96	93	92	91	98	106	113	118	130	103
1913	123	113	101	91	91	95	97	98	113	122	134	140	101
1914	131	124	116	91	92	96	101	104	113	110	122	131	103
1915	136	116	87	91	91	90	90	93	104	114	125	132	93
1916	130	119	101	100	103	106	110	116	125	142	155	164	114
1917	166	170	136	149	156	156	154	160	175	181	187	203	158
1918	210	220	178	162	168	165	182	196	202	212	233	261	186
1919	259	183	189	203	220	197	211	225	219	237	267	295	207
1920	287	252	222	209	214	198	210	233	239	253	280	296	227
1921	259	155	161	133	133	123	152	163	164	190	221	238	152
1922	167	169	130	128	131	123	135	129	144	177	204	220	140
1923	184	161	157	130	132	125	129	136	160	172	213	212	151
1924	175	175	127	123	128	129	131	148	168	183	212	231	145
1925	230	193	153	151	153	161	164	164	163	182	218	223	165
1926	193	169	155	158	159	158	157	159	174	189	218	230	163
1927	203	175	134	136	134	127	135	146	162	179	209	218	147
1928	194	177	147	148	152	145	152	161	179	181	206	220	162
1929	186	186	177	150	156	161	165	179	177	202	216	221	169
1930	194	174	137	136	129	119	122	129	140	148	157	141	169
1931	125	104	107	109	93	95	98	103	113	118	133	121	102
1932	99	84	75	74	70	69	77	84	89	111	124	127	79
1933	100	64	62	63	67	56	93	87	96	116	128	116	89
1934	87	88	83	82	78	74	75	89	107	113	134	124	87
1935	122	131	105	114	121	117	115	121	141	146	155	152	123
1936	124	138	117	108	112	113	116	122	124	137	171	148	116
1937	119	107	112	117	104	100	112	119	134				
1938													
1939													

*To replace table 13, p. 32, Mich. Tech. Bul. 139.

Table 13. Index numbers of farm prices of Michigan dairy products, 1910-37* (1910-14 = 100) (milk, butterfat).

Year	January	February	March	April	May	June	July	August	September	October	November	December	Weighted average
1910-14	115	110	103	96	85	83	86	94	101	109	118	120	100
1924-28	168	166	163	158	150	147	150	153	158	163	165	171	158
1910	111	102	100	100	84	84	86	87	101	106	110	110	97
1911	105	100	96	80	72	72	79	87	92	102	115	118	91
1912	114	109	102	101	89	81	86	92	101	111	123	130	101
1913	125	123	115	105	93	88	88	97	106	112	120	137	106
1914	122	114	108	95	88	88	93	100	106	115	122	114	104
1915	124	119	112	102	91	89	92	94	99	106	115	125	104
1916	118	115	119	110	100	93	99	109	116	131	141	144	115
1917	145	148	148	142	131	124	145	154	165	172	179	202	152
1918	185	197	186	175	160	149	162	183	210	219	231	253	189
1919	243	214	211	225	211	196	209	230	236	251	256	256	226
1920	249	242	240	237	215	210	219	210	235	226	225	180	224
1921	176	157	160	158	125	129	129	153	150	153	154	155	146
1922	136	136	129	129	127	127	131	133	140	146	162	183	138
1923	180	171	169	167	154	145	154	163	173	175	178	181	166
1924	179	177	163	148	137	137	144	140	146	145	143	153	150
1925	152	147	153	153	148	146	151	155	160	168	171	172	155
1926	165	162	158	152	146	146	146	152	155	162	167	177	156
1927	172	174	177	174	158	151	153	153	162	169	171	176	164
1928	174	169	167	165	160	154	158	165	170	173	174	178	166
1929	176	174	178	167	162	155	155	162	165	173	170	161	165
1930	145	140	136	141	136	126	128	138	150	145	138	126	137
1931	114	105	106	104	92	85	89	99	106	109	100	98	99
1932	86	78	76	71	68	64	64	69	71	69	71	74	71
1933	71	66	64	65	72	74	87	82	86	87	89	80	77
1934	75	87	92	89	88	90	92	101	99	99	108	110	94
1935	113	124	114	119	102	92	94	98	101	108	115	124	107
1936	127	130	118	116	108	108	122	130	132	131	131	132	122
1937	134	132	134	131	125	120	120	125	132				
1938													
1939													

*To replace table 14, p. 33, Mich. Tech. Bul. 139.

BULLETIN REVIEWS

Special Bulletin 287.—The Standard of Living of Farm Families in Selected Michigan Communities.—Mumford, Eben, Thaden, J. F., and Spurway, M. C.—In this study emphasis was placed upon family and farm practices, home equipment and surroundings, educational activities and achievements of youth and adults, membership and participation in institutions and special interest groups, and use of leisure. Data were obtained from 376 farm families in southern Michigan by workers using score cards, one for the standard of living with 83 items and the other for farm practices with 60 items, each card totaling 1,000 points. More than half of the items contributing to a high standard of living required little or no cash outlay but depended primarily upon the use of time in various family practices, in arrangement and beautification of the home and its surroundings, and in participation in the educational, organizational and recreational programs of the community. The families rating highest in standard of living also scored highest in farm practices. Standards of living and farm practices were more closely correlated than were standards of living and income.

Seventy per cent of the farmers with low farm practice ratings had only an eighth grade education or less, while 75 per cent of those with high farm practice ratings had attended high school or college. Farmers participating in the organizational and institutional life of their communities had a higher standard of living than non-members; they farmed larger acreages, had an average of three years more schooling, read more, and 83 per cent of their families were active in extension and Smith-Hughes work as compared with 23 per cent of the other families.

The adjustments that the families made to the depression were of two types: (1) for 71 per cent, more of their food and fuel was obtained from the farm; (2) adjustments requiring little or no expenditure of money, such as making more use of the opportunities furnished by the community and substitution of inexpensive types of recreation for the commercial forms. None of the families received relief or public assistance of any kind during the depression and none desired to exchange his lot for that of the urban dweller, though several formerly had lived in cities. (47 pp., 15 tables, 1 fig.)

JOURNAL ARTICLE ABSTRACTS

The Influence of Contaminating Bacteria on the Results of the Microscopic Test for Streptococcic Mastitis.—Bryan, C. S. and Nelson, E. A.—Amer. Jour. Public Health. 27(9): 914-917. 1937. (Journal Article No. 282 (n. s.) from the Michigan Agricultural Experiment Station.)—The microscopic examination of properly collected milk samples that have been incubated at 37° C. for at least 12 hours is an accurate means of diagnosing streptococcic mastitis in dairy cows. Contaminating bacteria get into the milk as a result of improper technic in collecting samples. These contaminating bacteria also reproduce during the necessary incubation period. The large numbers of those bacteria may overshadow the microscopic field, thereby obscuring the streptococci if present in small numbers. In addition, metabolic products of the contaminating bacteria may inhibit the growth of the streptococci. *Escherichia coli, Bacillus subtilis,* and *Staphylococcus aureus* in decreasing order alter the accuracy of the results of the microscopic test. Bacteria other than streptococci that may be present in the udder and therefore present in the milk sample do not greatly interfere with the accuracy of the microscopic test for streptococcic mastitis, since the reproduction of the streptococci is only slightly reduced in their presence. *Brucella abortus* and micrococci are of this type. Placing 0.1 cubic centimeter of a sterile 1-500 aqueous dilution of brilliant green into each tube prior to collecting a 10 cubic centimeter sample gives a final dilution of 1-50,000 brilliant green in the milk. This dye greatly inhibits these contaminants, thereby increasing the efficiency of the test if such bacteria are present. It is essential to use proper technic in the collection of milk samples; so that contaminating bacteria do not gain entrance and to be sure that the streptococci present do not get in from sources outside the udder. In addition, the dye should be added as a preservative to inhibit the bacteria that may invade the udder and thereby be present in the sample.

The Drought Resistance of Quack Grass Under Various Degrees of Fertilization with Nitrogen.—Dexter, S. T.—Jour. Amer. Soc. of Agronomy. 29: 568-576. 1937. (Jour. Article 291 (n. s.) from Michigan Agricultural Experiment Station.)—In considering the hazards to which quack grass may be subjected in any control program, an attempt has been made to segregate various of the injurious factors. Injury from any particular hazard or combination of hazards may be conditioned by the previous physical environment or the organic nutrition of the plant. Rhizomes of quack grass were taken from field plats that had been fertilized at various rates with ammonium sulphate. No marked difference was seen in the drouth resistance of rhizomes from fertilized and unfertilized plats at the time they were brought in from the field. Exposure to drouth after a period of sprouting was more injurious to rhizomes from fertilized than from unfertilized plats. Rhizomes from fertilized plats were more subject to invasion by molds

than were rhizomes from unfertilized plats, particularly if somewhat injured by drying in the air. Rhizomes from fertilized plats sprouted more vigorously and were less able to recover in soil after sprouting than were rhizomes similarly treated but from unfertilized plats.

The Relation of Clarifying and Sterilizing Treatments to Sedimentation of Apple Juice.—Marshall, R. E.—Fruit Products Journal. 16 (10): 328-331. 1937. (Journal Article No. 303 (n. s.) from the Michigan Agricultural Experiment Station.)—All of the various modifications tried of a combination of enzymic (Pectinol A) clarification of fresh apple juice followed by rough filtration and then by germ-proofing filtration resulted in the deposition of an amorphous dark brown sediment or precipitate in three to five weeks when stored at 70° F. or after a few months storage at 32° to 35° F. Those desiring to use the germ-proofing filtration method of sterilizing apple juice should clarify the cider with gelatin and tannin rather than with pectinol. Pectinol-clarified juice which has been rough filtered may be flash-pasteurized or pasteurized in the bottle without sedimentation.

The Influence of Rate of Seeding Upon Certain Plant Characters in Barley.—Thayer, J. W., Jr., and H. C. Rather.—Jour. Amer. Soc. Agron. 29 (9): 754-760. 1937. (Journal Article No. 304 from the Michigan Agricultural Experiment Station.)—Studies involving six rates of seeding were conducted with Spartan, Michigan-Two-Row, Glabron, and Wisconsin No. 38 barleys during the seasons 1932 to 1934. The number of plants per unit are increased, but tillering, length of culm, length of head, number of kernels per head and weight of kernels decreased as the seeding rate was increased from ½ to 3 bushels per acre. All varieties yielded more at the 1-bushel rate than at the ½-bushel rate and less at the 3-bushel rate than at the 2½-bushel rate, but were not consistent in their responses to rates of seeding from 1 to 2½ bushels per acre.

The Bulletins of this Station are sent free when available to such individuals as may request them. Please request only those actually needed. Address all applications to the Director, Agricultural Experiment Station, East Lansing, Michigan.

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Regular Bulletins—

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Special Bulletins—

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91 Lime for Michigan Soils.
94 The Financial History of a Twelve-Year-Old Peach Orchard.
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110 Special Report of the Upper Peninsula Experiment Station.
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227 Motor Truck Marketing of Michigan Fruits and Vegetables.
228 The Rock Garden.
229 Rural School Organization in Michigan.

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230 Success and Failure in Spraying for Scab and Codling Moth.
231 Agricultural Land Classification and Land Types of Michigan.
232 The Michigan Pear Industry, Its Status and Trends.
233 Experimental Studies in Feeding Fattening Lambs.
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235 Motor Truck Marketing of Michigan Livestock.
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237 Trends in Cherry Production in Michigan.
238 Some Wood Borers Attacking the Trunks and Limbs of Deciduous Trees and Shrubs.
239 The Principal Grape Insects in Michigan.
240 Sudan Grass as an Emergency Pasture on Light Soils.
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78 The Fruit Tree Leaf Roller.
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12 4-H Hot Lunch Clubs.

*Bulletins listed in bold face type are recent publications of this Station.
†A charge of 10 cents is made for out-of-state requests for Extension Bulletin 169.

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152 A Study of Stewart's Disease of Sweet Corn Caused by *Phytomonas stewarti.*
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*154 **The Toxicity of Combinations of Nicotine, Under Michigan Conditions, to the Tree and to the Codling Moth.**
*155 **The Fusarium Yellows Disease of Celery.**

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PROGRESS REPORT UPON THE INVESTIGATION OF OFF-FLAVORED TURKEYS

P. J. SCHAIBLE, RUTH GRISWOLD, J. A. DAVIDSON AND E. J. MILLER
SECTIONS OF AGRICULTURAL CHEMISTRY, HOME ECONOMICS AND POULTRY HUSBANDRY

During recent years turkey feeding practices have changed considerably, and the discovery of a small percentage of birds from Michigan and other parts of the United States that are unpalatable after cooking, has made it desirable to check carefully the effect of dietary innovations upon the palatability of the cooked bird. The consumer has complained chiefly that some birds possessed a fishy flavor and odor after roasting. Turkeys are served most frequently upon festive occasions to larger-than-ordinary groups and thus off-flavors and odors can cause turkeys to lose a well-deserved public popularity far beyond the relative proportion of objectionable birds. For that reason, investigation was started recently to obtain further information on the cause and prevention of this trouble.

Cosby and Knowlton (1) have shown that the factors involved in the production of fishy-flavored turkeys are very complex and do not lend themselves to an immediate and positive solution. They have obtained data to indicate that combinations of fish oils and fish meals, further complicated by the grades and levels used, produce some birds with off-flavors and they recommend that the use of fish meals and fish oils be discontinued two months before slaughter. Experimental studies conducted by Marble, Hunter and Knandel (2), Asmundson (3), and the United States Department of Agriculture (4) have also shown that the practical solution of this problem is the elimination of fish oil from the ration prior to finishing. Preliminary indications of the latter group of investigators have been that two conditions must exist to develop objectionable turkeys. "The first is the presence of free fatty acids in the alimentary tract. The second is the presence of trimethylamine or of betaine, the former of which is found in fish oils and fish meals and the latter of which occurs in a number of plant products." Turkey hens have been found to cause more trouble than turkey toms.

Experimental

April-hatched turkeys were supplied until Oct. 15, 1937 the following mash containing 2 per cent of animal feeding grade of cod liver oil and 5 per cent of white fish meal. Corn and oats were also fed in hoppers. At this time the birds were consuming about twice as much grain as mash, so the average level of intake of this grade of cod liver oil was 0.67 per cent and that of fish meal was 1.7 per cent.

Mash

Ground corn	15	Soybean oil meal	20
Ground oats	15	Dried whey	5
Bran	6	Salt	0.5
Flour midds	5	Animal feeding grade of cod liver oil	2
Dehydrated alfalfa meal	10	Oyster shell flour	1.5
Meat scraps	15		
White fish meal	5		

On Oct. 16, 1937 turkey No. 1 was slaughtered and the rest of the turkeys were fed the foregoing mash with the cod liver oil and fish meal removed, soybean oil meal replacing the fish meal. Whole corn was fed *ad lib.* Ten to thirty days before killing the remaining turkeys were fed individually as follows:

Turkey No.

1. Fed a ration containing approximately 0.67 per cent of an animal feeding grade of cod liver oil and 1.7 per cent of white fish meal. Starved over night, slaughtered, hung 5 days in refrigerator and drawn. Cooked the following day.
2. Fed for 10 days an all-mash ration containing 4 per cent of an animal feeding grade of cod liver oil. Slaughtered, hung 5 days in refrigerator, drawn and cooked the following day.
3. Fed for 16 days the same ration as turkey No. 2 but was drawn immediately after slaughtering. Cooked the following day.
4. Fed similarly to turkey No. 3, drawn and skinned immediately after slaughtering. Carcass and skin were cooked separately the following day.
5. Fed for 16 days an all-mash ration containing 2 per cent of animal feeding grade of cod liver oil. Drawn immediately after slaughtering and cooked the following day.
6. Fed for 16 days an all-mash ration containing 2 per cent of an animal feeding grade of cod liver oil **concentrate.** Drawn immediately after slaughtering and cooked the following day.
7. Fed for 30 days entirely on whole corn. Drawn immediately after slaughtering and cooked the following day.
8. Fed for 14 days an all-mash ration containing 4 per cent of a medicinal grade of cod liver oil. Drawn immediately after slaughtering and cooked the following day.
9. Fed for 14 days an all-mash ration containing 0.4 per cent trimethylamine hydrochloride. No cod liver oil. Drawn immediately after slaughtering and cooked the following day.
10. Fed for 14 days an all-mash ration containing 4 per cent betaine hydrochloride. No cod liver oil. Drawn immediately after slaughtering and cooked the following day.

The method of roasting used was adapted from Lowe's (5) method for half chickens. The turkey was weighed, washed, stuffed with bread, butter and salt, then trussed and weighed again. A meat roasting thermometer was placed in a definite spot in the heavy musculature of the thigh. The bird was placed, breast down, on a wire rack in an open baking pan. It was brushed with butterfat, covered with cheesecloth, brushed with butterfat again and baked uncovered. Baking was done in a gas oven at 300° F. until the meat thermometer in the bird registered 185° F. The turkey was basted occasionally during roasting, and turned on its back when about half done.

The skin of turkey No. 4 was rolled and cooked by itself for 80 minutes, reaching an internal temperature of 212°F.

Table 1. Cooking and palatability data upon turkeys.

Turkey No.	Live Weight	Sex	Min. Cooked	Cooking Odor	FLAVOR											Judges' general comments as to palatability
					Breast Meat		Inside Thigh		Outside Thigh		Skin Hot	Skin Cold	Stuffing	Abdominal Fat	Drippings	
					Hot	Cold	Hot	Cold	Hot	Cold						
1	11.5	F	150	N	N	N	N	f	N	N	o	o	N	N	o	Fair
2	12.9	F	190	O	N	—	o	—	N	—	O	—	N	N	O	Objectionable
3	13.2	F	235	o	N	f	g	g	o	N	o	o	N	N	O	Objectionable
4	12.8	F	225	o	N	N	g	g	N	N	N	N	N	N	N	Fair
5	14.1	F	165	o	N	N	g	g	N	N	o	o	N	N	N	Fair to good
6	14.7	F	140	N	N	N	g	g	N	N	N	N	N	N	N	Good
7	22.6	M	177	N	N	N	N	N	N	N	N	N	N	N	N	Excellent
8	15.8	F	173	N	N	N	N	N	N	N	o	o	N	N	o	Good
9	13.7	F	165	N	N	N	N	N	N	N	N	N	N	N	N	Good
10	13.2	F	194	N	N	N	N	N	N	N	N	N	N	N	N	Good

N....Normal
f....Slightly fishy
g....Slightly gamey
o....Slightly objectionable
O....Objectionable

Table 1 gives the cooking data on the turkeys and the general comments of the judges as to the palatability of the various portions of the carcasses.

Tasting was done by a committee of four, augmented on occasions by others, who concurred in general with the opinions of the regular judges. The cooking odor, the light meat and skin of the breast, the dark meat on the inside and outside of the thigh and the skin in that region, the stuffing, the tryings of the abdominal fat, and the drippings were judged regularly and occasionally the giblets and other portions of the bird as well as gravy made from the drippings. The carcass was also tasted cold after at least one day in the refrigerator.

Observations

From these preliminary experiments it is evident that relatively short periods of feeding prior to slaughtering are sufficient to produce off-flavors in the cooked birds providing the objectionable substance is present in sufficient amounts in the feed. For example turkey No. 2 was on 4 per cent of an animal feeding grade of cod liver oil for only 10 days and yet the cooked bird was objectionable to the judges. It should be stated that this intake is several times that necessary to supply the requirements for vitamins A and D. However, the inclusion of 2 per cent of a cod liver oil **concentrate,** also considerably more than would be fed in ordinary practice, was without bad effects on the palatability of the cooked bird. As is shown by the data on turkey No. 5 this same percentage of the straight oil, a level frequently used in turkey mashes that are to be fed with grain, was slightly objectionable despite the fact that the viscera were removed from the turkey at the time of slaughtering.

That the trouble does not come entirely from *post mortem* changes in the intestine is also indicated by the observations upon turkey No. 3 which was on the same objectionable ration as turkey No. 2 but was drawn immediately after slaughtering and yet was considered unsatisfactory by the judges. When turkeys were drawn at the time of slaughtering, concentrations of betaine or trimethylamine, greater than would be found ordinarily in turkey rations, did not cause off-flavors or odors in the cooked birds. Holding these birds in the refrigerator for a few days before drawing, as would be customary practice, might have resulted in unpalatable carcasses as has been suggested (4), but this was not tried. The fact that turkeys No. 9 and No. 10 were satisfactory would support the view that any undesirable effect from this source would be *post mortem.*

Medicinal cod liver oil was found unobjectionable when fed at a level that was found inadvisable for an animal feeding grade of oil. The skin of turkey No. 4 which was removed at the time of slaughtering and rolled and cooked by itself, was not considered particularly unpalatable by the judges but it should be noted that it had not been cooked under the same conditions as if it had been on the turkey. The skinned turkey No. 4 was better than unskinned turkey No. 3 but nevertheless was not considered quite satisfactory to the committee.

In general the most unpalatable portion of the cooked turkeys was the skin. In the questionable turkeys this gave a strong bitter aftertaste but was not fishy in the judgment of the committee. It was bad tasting,

however, as were the drippings, which probably obtained the objectionable substance from the fat that tried out of the skin during roasting. Gravy made from such drippings had an unpleasant flavor and would spoil the taste of otherwise excellent meat.

While the identity of the substance which caused cod liver oil of animal feeding grades to produce off-flavors and odors in cooked turkeys was not learned, these experiments together with those already reported, point to the advisability of:

(1) Eliminating animal feeding grade of cod liver oil from turkey rations several months prior to slaughtering, or replacing it with

(2) A vitamin A and D concentrate, or

(3) A higher quality cod liver oil.

Further studies will be made upon this problem.

Literature Cited

1. Cosby, H. E., and Knowlton, F. L., Third progress report on fishy flavored turkeys. Ore. St. Col. 1937.
2. Marble, D. R., Hunter, J. E., Knandel, H. C., and Dutcher, R. A., Fishy flavor and odor in turkeys. The effect of cod liver oil (not U.S.P.) and white fish meal. Poul. Sci. **16**; 363. 1937.
3. Anonymous. The off-flavored turkey problem. U. S. Egg and Poul. Mag. June 1937.
4. Shrader, H. L., Mimeographed letter to poultry specialists. Extension Service, U. S. Dept. of Agr. Sept. 18, 1937.
5. Lowe, Belle, Personal communication to the authors.

SOUTHERN-GROWN VS. LOCALLY GROWN TOMATO PLANTS

H. L. SEATON AND M. C. STRONG
SECTIONS OF HORTICULTURE AND BOTANY

Recently large areas in southern states have been devoted to producing tomato plants for northern canning companies, truck farmers and home gardeners. A number of important questions arise concerning the relative value of the southern-grown plants as compared with plants grown locally. It is generally agreed among Michigan growers that disappointing results have often come from the use of the southern plants. Root knot, collar rot (early blight), Phoma, bacterial canker, Fusarium wilt, Septoria leaf spot and mosaic are often prevalent in the sections where the plants are produced. Most of these diseases are not detectable in the young plants and frequently are responsible for considerable losses in transit and after the plants are set in the field. The cumulative effects of the numerous handlings given during the pulling, bunching, packing and shipping often result in the delivery of badly wilted plants with poor root systems. These over-hardened plants recover slowly when set in the field, a considerable number of

replants are often needed and frequently the first fruits are small and rough. The principal reasons for using southern-grown plants are that they may be obtained in any quantity, the initial cost per acre for plants is lower than for home-grown plants, and the canner and grower does not have the bother of growing the plants locally. Whether the advantages over-weigh the numerous disadvantages of the southern grown plants is questionable. The preliminary experiments here reported were undertaken to answer these questions.

1936 Experiment

Arrangements were made early in 1936 with several Michigan canners to obtain plants grown for them in Mississippi, Georgia, southern Illinois, and Kentucky for a comparative test with plants of the same

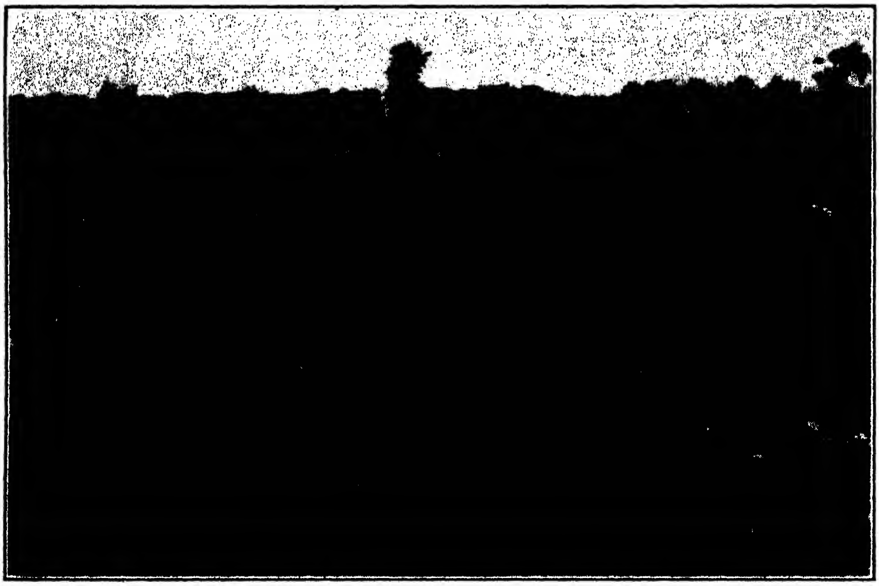

Fig. 1. View of 1936 experimental plots taken July 6. The two rows to left are plants grown in Georgia. Note the uneven stand and the smaller size. The two rows to the right are plants grown locally in flats.

variety grown at the Experiment Station at East Lansing. The variety used was the John Baer. Seeds for the locally grown plants were planted March 30. One lot of seedlings was spotted 80 plants to a flat on April 15 and another lot was pricked off in 3″ x 3″ x 4″ veneer bands on April 22. Both lots of plants were grown in a cold frame and were in excellent condition when set in the field. Plants from Mississippi and Georgia arrived May 25 and 28, respectively. They were large and badly wilted on arrival. The bundles were broken, the plants heeled-in, watered and held until the time of field planting. The plants from Illinois and Kentucky arrived June 2 and 4 and were set in the field at that time.

Table 1. Results of 1936 tests with locally grown and southern-grown tomato plants at East Lansing.

	Locally Grown		Southern-Grown Plants						
	3"x3"x4" veneer bands	Flat grown 80 plants per flat	Miss.	Ga.	Ill.	Ky.	Ky.	Ky.	Ky.
Variety	John Baer	John Baer	John Baer	John Baer	John Baer	John Baer	Clark's Early	Marglobe	Baltimore
Date Set in Field	May 30	May 30	May 30	May 30	June 2	June 4	June 4	June 4	June 4
Number of Replants needed per 100 plants	0	0	24	60	2	0	2	2	6
Stand of plants at end of season (per cent)	98	84	78	86	96	100	92	98	92
Yield in tons per acre									
Up to Aug. 15	.32	.13	.13	.11	.05	.09	.06	.12	.10
Up to Sept. 1	1.81	1.29	.79	.23	.82	.81	.34	.28	.48
Up to Sept. 5	4.00	3.36	1.59	1.70	2.13	2.32	.67	.62	1.09
Total yield for season	5.09	4.11	1.92	4.87	6.06	6.62	5.47	5.78	6.37
Average number of ripe fruit per plant	36	32	28	29	24	24	23	18	24
Average weight of fruit (ounces)	2.9	2.7	3.6	4.1	4.7	4.6	4.5	5.6	5.1

The locally grown plants and those from Mississippi and Georgia were transplanted in the field May 30, in rows 6 feet apart and 4 feet apart in the row. Two rows of 25 plants each constituted a plot. At the time of planting the soil was dry and loose and the poor root development of the southern-grown plants accounted for the large losses of these plants the first two days in the field. However, on June 1 and 2 about 2 inches of rain fell and the plants from Illinois and Kentucky were planted under ideal soil moisture conditions which accounts for the smaller number of replants required, as is shown in Table 1. The band- and flat-grown plants continued to grow after field setting while the southern plants required several weeks to become established. By July 1 the locally grown plants were twice as large as any of the southern-grown plants (Fig. 1). A rain of 0.96 of an inch occurred July 4 and no more occurred until August 20. An abnormal heat wave early in July produced drouth conditions which lasted until about September 1. After that date almost too much precipitation fell for the production of good quality fruit. Counts made on July 6 showed that the band- and flat-grown plants had an average of six clusters in bloom while the southern plants had only one. Practically all of these blossoms dropped without setting fruit and as a result of this and the larger size of the locally grown plants during the heat and drouth conditions which prevailed the yields from these plants do not compare well with those from the southern-grown plants, as is shown by the data given in Table 1.

Since unusually dry conditions prevailed in the southern states during the time the plants were growing there, and as similar conditions existed at East Lansing during the greater portion of the growing season, all of the plants were relatively free from leaf diseases until late in the season when these troubles were of little consequence. As the climatic conditions were not favorable for the spread of leaf diseases, no field spraying was done in 1936. Because of the abnormal climatic condition the only significant differences in the performance of the locally and southern-grown plants in 1936 were the larger number of replants required where the Mississippi and Georgia plants were used; the longer interval required by all of the southern-grown plants to recover from the effects of the treatments given them incident to their arrival in this section; and the greater number of fruit per plant from the locally grown plants.

1937 Experiments

The tests with southern- and locally grown plants were continued at East Lansing in 1937. The John Baer and Pritchard varieties were used and the southern plants all came from Georgia. The locally grown plants were handled in much the same manner as described for the 1936 experiments. Supposedly the same strains were seeded in Georgia for the plants from that source. The southern plants were grown by two large plant growers under the rigid Georgia requirements for certification. Official certification tags were attached to all bundles when they arrived. All of the Georgia plants were large, wilted, and showed considerable leaf spotting which was identified as early blight *(Alternaria solani)*. Several plants of each lot showed unmistakable root knot swellings on the roots. The plants were heeled-in, watered,

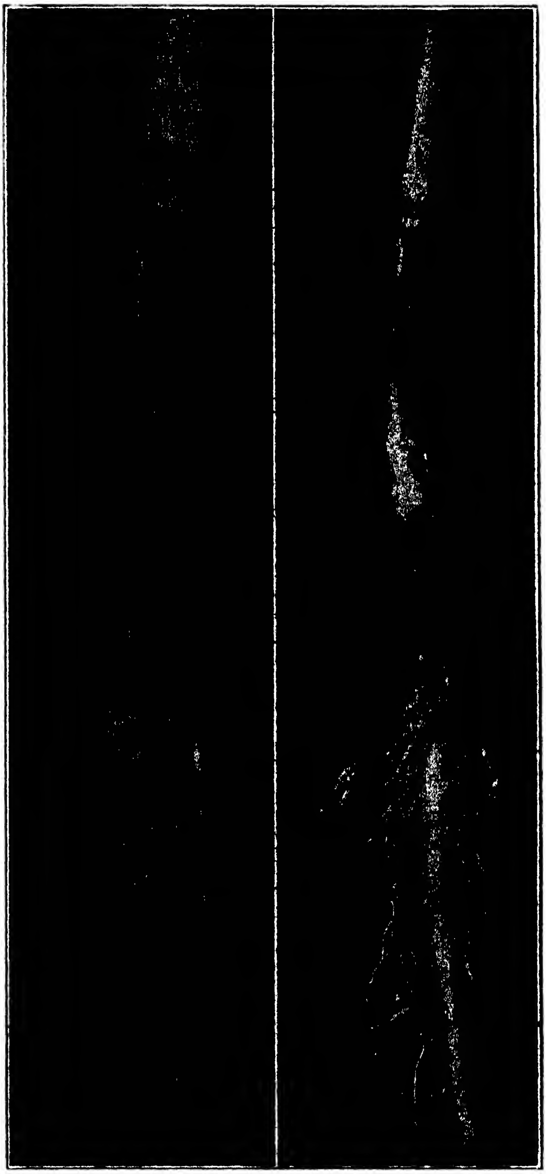

Fig. 2. A southern-grown tomato plant showing typical collar rot lesions on the stem and root knot swellings on the side roots. The enlarged section of the stem to the left shows the characteristic concentric zones of the disease.

and held for several days before they were set in the field. When they were lifted for field setting a number were discarded because of collar rot *(Alternaria solani)* lesions on the stems. Random samples were taken from each lot, and the individual plants of a sample were examined for the presence of leaf and stem diseases. Isolations were made from all stem lesions and in every case *Alternaria solani* was the fungus isolated. The results of the pathological examinations of the locally and southern-grown plants are given in Table 2. A typical infection of collar rot from one of these plants is shown in Fig. 2.

Table 2. Results of pathological examinations of leaves and stems of southern- and locally grown tomato plants.

	Number of Plants Taken at Random	Showing Leaf Spotting* (per cent)	Showing Collar Rot Lesions on Stem** (per cent)	Showing Healthy Stems (per cent)
Pritchard grown in veneer bands (Locally grown)....	50	0	0	100
Pritchard grown in flats (Locally grown)...........	50	0	0	100
Pritchard —Georgia (No. 1).......................	20	100	60	40
Pritchard —Georgia (No. 2).......................	50	100	70	30
John Baer—Georgia (No. 1).......................	14	100	50	50
John Baer—Georgia (No. 2).......................	25	100	52	48

*Leaf spotting was typical of early blight *(Alternaria solani)*
**Plantings were made from all collar rot lesions and the fungus *Alternaria solani* was isolated in every case. All lots of southern-grown plants showed some root knot *(Heterodera marioni)* but no actual counts were made.

The locally grown and the Georgia plants were set in the field May 31 in rows six feet apart with a distance of three feet between the plants in the row. The soil contained adequate moisture when the plants were set. Approximately 600 pounds per acre of a 5-10-5 fertilizer was applied in bands on each side of the row at the first cultivation. Several of the southern plants died from collar rot and it was necessary to replant several times. Climatic conditions in 1937 were nearly opposite those of 1936, that is, during the first 21 days of June some precipitation occurred on 19 days and this was accompanied by cool temperatures. The plants made little growth before July 1, but from the first the locally grown plants were larger. After July 1, favorable climatic conditions prevailed throughout the remainder of the season. Three applications of 4-6-100 Bordeaux with 2 pounds of calcium arsenate were applied under about 250 pounds pressure. The last application was made about the time the first fruits were beginning to color. Even with this spraying program the John Baer plots were so badly infected with early blight that harvest records were not taken. The Pritchard plots were harvested weekly and the fruit was graded according to the United States grades for cannery tomatoes. The results are reported in Table 3.

The data in Table 3 show that a larger number of replants were needed where the southern-grown plants were set than where the locally grown band- and flat-plants were used. This was largely the result of collar rot infection on the stems of the southern-grown plants. Several plants infected with collar rot apparently developed new root

Table 3. Results of 1937 tests with locally grown and southern-grown tomato plants at East Lansing.

(Variety—Pritchard)

	Plants Grown Locally		Southern-grown Plants	
	3"x3"x4" Veneer Bands	Flat Grown 80 Plants per Flat	Grown in Georgia (No. 1)	Grown in Georgia (No. 2)
Replants needed per 100 plants	0	3	8	21*
Stand of plants at end of season (Per cent)	100	100	100	94**
Yields in Tons per Acre				
Up to Aug. 20	1.64	.92	.77	.02
Up to Sept. 1	4.35	3.24	2.38	.07
Up to Sept. 5	16.26	13.38	9.57	.36
Up to Sept. 10	27.87	26.11	19.70	3.56
Total for Season	29.71	28.49	22.12	5.62
Tons of U. S. No. 1 per acre	21.20	20.74	12.75	3.44
Per cent U. S. No. 1	71	72	57	61
Per cent of fruit badly misshapened	4	5	15	20

*The greater portion of these were needed where the original plant had died with collar rot.
**These plants were removed because of mosaic and Fusarium wilt symptoms.

systems from the regions above the lesions. These and the later-set replants caused uneven stands on the plots with Georgia plants throughout the season.

A significant comparison of the number of replants required with southern- and locally grown plants was supplied by other experimental plots at East Lansing in 1937. In a fertilizer placement and analysis test, 960 southern-grown plants were set. Three replantings were necessary on these plots, and a total of 150 replants or 15.6 per cent of the original number set were required. In a test of canning varieties 800 locally grown flat-plants were used and only one replanting, re-

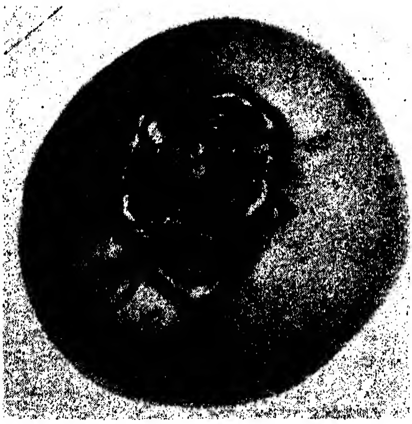

Fig. 3. Typical specimen of Phoma fruit rot, a disease which is sometimes brought into Michigan on southern grown tomato plants.

quiring 24 plants or 3 per cent of the original number set, was necessary. In still another test of early market varieties 660 locally grown band-plants were used. Only 6 replants or less than one per cent of the number were needed. Even with the three field sprays of Bordeaux, more early blight developed in the Georgia plants than on the home-grown plants. The disease developed first on the southern plants and spread rapidly to the other plots. In one lot of southern plants it was necessary to remove several plants just before the harvesting season as they developed Fusarium wilt and mosiac symptoms.

Fig. 4. Southern-grown tomato plants in the foreground and plants grown locally in veneer bands in the background. Photographed July 1, 1937. Both lots of plants were transplanted in the field on May 31.

The records show only slight differences between the performance of the locally grown band- and flat-plants with the exception of the larger early yields from the band-plants. Up to August 20 these plants produced nearly twice as much fruit as the flat-plants and a slight difference in favor of the plants grown in veneer bands was maintained throughout the season.

From early in the season the two lots of southern plants exhibited outstanding varietal differences and neither resembled the locally grown Pritchard plants in their growth habits. At the time of the first picking it was evident that neither lot was of the Pritchard variety. Those designated as Georgia No. 1 in Table 3 more nearly resembled

the Grothen's Globe variety and those listed as Georgia No. 2 were of the Marglobe type. Undoubtedly these varietal differences greatly influenced the results.

The yield of ripe fruits from the plants grown in bands up to August 20 was twice that of the Georgia No. 1 plants and 80 times that from the Georgia No. 2 plot. Up to September 10 the locally grown band- and flat-plants produced 50 per cent more fruit than Georgia No. 1 and eight times as much as Georgia No. 2. When total yields for the season are considered, the band-plants produced 7½ tons per acre more than Georgia No. 1 and 24 tons more than Georgia No. 2. Similar differences are shown for the locally grown flat-plants which gave 6 and 23 tons, respectively, more than the two lots of southern plants.

When considered on a graded basis, the yield of U. S. No. 1 tomatoes from the Georgia No. 1 plants was 8½ tons lower than that of the locally grown band-plants and 8 tons lower than the plants grown locally in flats. The yield of U. S. No. 1 tomatoes from the other lot of Georgia plants was approximately 17 tons lower than the locally grown plants and 9 tons lower than the Georgia No. 1 plants. Varietal differences in susceptibility to cracking influenced the percentages of U. S. No. 1 fruits from the four lots of plants as did the higher percentage of misshapened fruits, particularly from the lower clusters on the two lots of southern plants. The latter fact indicates that a hardening effect was operative during the early growth of the southern plants which was not shown by those grown locally.

By September 15 practically all of the fruits by the locally grown plants and those designated as Georgia No. 1 had been harvested, but a large number of fruits still remained on the other lot of Georgia plants when a heavy frost occurred on September 16. This accounts largely for the differences in the yields of the two lots of Georgia plants.

Discussion

It does not seem feasible to draw definite conclusions from the results of the two years' experiments here reported as differences existed between the strains and varieties used and the climatic conditions varied widely between the 1936 and 1937 seasons. However, the rather meager data presented and observations made over the state for several years in sections using both locally and southern-grown tomato plants lead to several controversial contentions.

The growing season in all parts of Michigan is relatively short for tomatoes and the returns in large measure depend upon early yields with a large percentage of the crop maturing before early fall frosts. This makes it necessary to grow only the earlier maturing varieties, such as the John Baer and varieties of similar season. These varieties are more susceptible to leaf diseases, and the quality of the fruit they produce depends more upon how well they retain their foliage than is true with the later maturing varieties grown in the states further south. The fact that the southern plants recover slowly from the handlings incident to their arrival in this section as well as the still later recovery of the large number of replants required, give a decided advantage from the beginning of the season to locally grown plants in reducing the hazard of early frosts in the fall. The returns of the market grower are largely influenced by the higher prices received

for the portion of the crop maturing early in the season and he cannot afford to depend on southern-grown plants for early yields.

The disease problem presented by the southern plants is of paramount importance. This is revealed by several years experience of Michigan growers who have used these plants. The tomato canning industry experienced a setback in 1927 when a serious outbreak of bacterial wilt destroyed a considerable acreage in some sections of Michigan. This disease had never been reported from Michigan before that year and has not occurred since. A careful check showed that the plants used in the diseased fields came from a southern section where the disease was prevalent. In 1935 a significant reduction in stand as a result of bacterial canker infections was observed in sections where southern plants were used. That same year several serious infections of Phoma fruit rot were observed on the fruits of the southern-grown plants. Like bacterial wilt, Phoma seldom occurs in Michigan except when brought in on southern plants. It is a serious tomato disease in the southern states. Owing to the unusually dry climatic conditions in Georgia and other southern states in the spring of 1936 and similar dry conditions in Michigan that year, no serious outbreak of disease occurred. However, in 1937 the climatic conditions in both sections were favorable for the development of fungous diseases, early blight in particular. Considerable losses of plants from collar rot and heavy defoliation from leaf infections were experienced. The results on the experimental plots at East Lansing were general for the state, and in many cases where field spraying was not followed the defoliation resulted in greatly reduced yields of poor quality fruit.

Though the diseases affecting the leaves, stems and fruits of a plant are the first observed by growers, still more serious problems are presented by the soil inhabiting diseases such as root knot and Fusarium wilt which invade the roots of the plants. Root knot is a disease of wide distribution in the sandy soils in the southern states and is caused by microscopic nematodes or eel-worms *(Heterodera marioni)*. These nematodes penetrate the roots of the plant, feed on the plant juices, and increase enormously in size. The root is stimulated to produce swellings or galls which are characteristic symptoms of the disorder. Infected tomato plants are usually stunted and produce few fruits. Many different kinds of economic plants as well as weeds are attacked by this pest and once it is introduced into a sandy soil, it is difficult to control. The same nematode causing root knot of tomatoes produces root knot of strawberries and other plants. Strawberry plants and other nursery stock showing root-knot galls do not comply with the state nursery inspection laws and may not be shipped. Since this offers a serious problem in sections growing nursery stock, growers are warned against the danger of importing this parasite on tomato and other plants from the southern states. The roots of all plants should be carefully examined before they are set in the field. Fusarium wilt is a widely distributed tomato disease and is serious in the southern states. The fungus is known to live in the soil for many years and when it is present only the later maturing wilt resistant varieties can be grown successfully. There are no reliable external symptoms of this disease in the young plants.

Too often the initial cost of plants to set an acre of canning tomatoes is the determining factor in whether southern- or home-grown plants

are used. Where the plants are spaced 4 by 6 feet in the field, approximately 2,000 plants are required for an acre. The prices for southern-grown plants in Michigan varies from $1.75 to $2.50 per 1,000 which would make the cost of plants between $3.50 and $5.00 per acre. Home-grown flat- and cold-frame plants are usually supplied at about $5.00 per 1000 making the cost per acre about $10.00. Thus a price differential of between $5.00 and $6.50 per acre exists between the plants from the two sources. An increase of from one-half to one ton of tomatoes per acre would more than offset the cost of the locally grown plants.

It is not the purpose of this article to condemn all southern-grown tomato plants and in the foregoing discussion southern-grown plants in general have been compared with properly grown local plants. However, where good plants are produced locally they require the utmost care regarding such matters as the selection of good seed stocks; proper seed treatments; sanitation and sterilization of the lumber, sash, and soil used in the plant beds; constant attention to watering, ventilation and general care of the seedlings, and a rigorously followed spraying schedule if healthy, disease-free plants are produced. Too often such a schedule is not followed and the locally grown plants may be little if any better than the southern plants. Still another factor of considerable consequence must enter into this discussion; that is, few growers realize the problems that a canning company contracting a large acreage would have in supplying locally grown plants to the growers. Between two and three million plants would be required to plant 1,000 acres. This would require at least 5,000—3-feet x 6-feet hot sash if approximately 500 plants were grown per sash besides facilities for heating, flats, and other equipment. On the other hand, if the plants are grown in open beds in the south the expense of this equipment is largely eliminated and a supply of cheap labor is available. If care is exercised in the selection of isolated locations on disease-free soils, proper supervision given to the seed stocks, the planting, general care, spraying, and the handling of the plants, fairly satisfactory plants may be produced cheaply. Under present conditions it seems necessary that some such arrangements must be followed for a portion of the plants required for the canning acreage of tomatoes in Michigan, at least until a more satisfactory method of growing plants locally is developed. However, only the larger canning companies can furnish the proper kind of supervision necessary for such an undertaking. The individual grower of market tomatoes and the home gardener who orders direct from an unknown southern plant grower has no assurance as to the conditions under which the plants were grown nor the kind of plants he will receive. The whole question needs to be investigated further and the experiments will be continued.

SOIL LOSSES IN BERRIEN COUNTY

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Although the loss of surface soil by sheet and gully erosion has been widely discussed the last two years by many groups in Michigan, little information was available as to exactly how much erosion actually was taking place. To make a visual demonstration that might be viewed by visitors to the Berrien County Soil Conservation Service demonstration project, run-off plots were laid out on two different soil types and two different slope conditions.

Fig. 1. This shows one set of plots. The soil in the containers below the plots represents the soil lost from the respective plots as influenced by the treatment.

These plots were one-hundredth of an acre in size and were enclosed with a 10-inch board set 6 inches in the ground, to keep all the water that fell outside of the plots from running in and to keep the water that fell on the plots inside. A cistern was constructed at the lower end of each plot to collect all the water and soil that ran off the plot.

Rainfall and run-off records were started June 1, 1937, and will be continued for a year. At this time, however, records for the period of June 1, 1937, to Oct. 1, 1937, only are available.

Inasmuch as these plots are located in a fruit section, treatments were established to correspond to cultural practices in orchards, such as clean cultivation up and down the slope, complete sod, and cross-slope cultivation with a four-foot sod strip in every tree row.

Details of the treatments are:

Left-hand plot—Corn was planted in rows lengthwise of the plot and was cultivated in the customary manner up and down the hill.

Center plot—Left in blue grass sod.

Right-hand plot—Corn was planted in rows across the slope and was cultivated in the customary manner across the slope. Four-foot strips of sod at 16-foot intervals were allowed to remain.

The necessary apparatus to make accurate determinations was not available at the project, and the results shown in Table 1 are only approximately correct. However, these results check closely with the visual observations made on soil and water collected in the cisterns at the foot of the slope.

Table 1*.

Soil	Per cent of Slope	Tons Soil Loss per Acre with			Per cent of Rainfall Lost by Run-off		
		Cultivation Up and Down Slope	Sod	Cultivation Across Slope and Sod Strips	Cultivation Up and Down Slope	Sod	Cultivation Across Slope and Sod Strips
Hillsdale Loam......	13½	152.	.2	26.	37.5	5.4	19.4
Hillsdale Sandy Loam	6	40.	0	2.	28.6	7.4	11.4
Coloma Sandy Loam.	14	26.	.06	1.	9.2	1.3	3.5
Coloma Sandy Loam.	6	9.	0	.9	7.2	0.5	4.6

*Results are for period June 1, 1937, to Oct. 1, 1937.

The results shown in Table 1 and Fig. 1 indicate that sheet erosion is each year removing large amounts of fertile top soil—but is removing it in thin layers, not readily observed under field conditions.

The Soils Department of Michigan State College has cooperated in making moisture determinations throughout the growing season to study the effect of these various treatments on soil moisture. This information will undoubtedly be published at some future date.

These observations made at Benton Harbor cover only a short period and hence are not advanced as final. They are, nevertheless, in accord with research data obtained elsewhere.

AGRICULTURAL LAND RATINGS AND THE FARMERS' LEVELS OF LIVING

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How important is it to settle on good land?

This article attempts an answer to that question by relating the soil and topographical conditions in the agricultural counties in Michigan to the levels of living of the farm population of those counties. The object has been to determine to what extent satisfactory living conditions have been concomitant in space with good land, regardless of whether other factors, such as accessibility to markets, or the use of progressive farming methods have entered into the result. Underlying this study is the common sense assumption that if there is a proximity, within a single state, between the quality of the land and variations in the levels of living derived from its use, these two are in some way related.

Twenty-nine counties were selected for study. They are those in which more than half the total population was classed as "rural-farm" in the 1930 U. S. Census. Those included are listed in Table 1, and are shown on the maps which follow.

The relative suitability of the land for agricultural purposes in these counties has been determined by Veatch[1]. Such factors as the type and quality of soil, topography, natural drainage, and to some extent the native cover of plant growth, have been taken into account in the rating of the areas. To obtain a ranking of the counties according to the quality of their land, each percentage of first class land was given a weight of 3, each percentage of second class land a weight of 2, and each percentage of third class land a weight of 1. The use of this technique rests on the assumption that there is the same measure of qualitative difference between first and second class territory as between second and third. All the land in the counties is taken into account. Actually, of course, only a part of it is used for agriculture, in each county. This is, then, a possible source of error. It is probable, however, that errors arising from this source are not so large as to destroy the validity of the results which follow.

No one existing set of figures gives a complete picture of the farmers' levels of living. For that reason several complementary sets of data were used. They are: (a) the standard of living index, based on the percentage of farm homes with electricity, telephone, radio, automobile, and location on an improved road, as of 1930, compiled by the Research Division of the Resettlement Administration; (b) the per capita retail sales by counties, from the Michigan Retail Census of American business for 1933; (c) the average value of farm dwellings, 1930, from the

[1]Veatch, J. O., Agricultural Land Classification and Land Types of Michigan. Mich. Agri. Exp. Sta. Spec. Bul. 231.

Table 1. Land ratings and level of living indices: 29 Michigan counties.

County	Land Rating		Standard of Living Index		Retail Sales Per Capita		Average Value, Farm Dwelling		Per Cent Farm Families on Relief		Per Cent of Children 14-17 at School	
	Rating	Rank	Index	Rank	Sales	Rank	Value	Rank	Per Cent	Rank	Per Cent	Rank
Lake	120	1	20.3	7	$90	3	$956	2	46.7	2	69.9	16
Oscoda	123	2	16.8	3	100	5	935	6	62.4	1	69.4	14
Alcona	151	3	18.1	5	63	1	1,037	11	25.4	12	71.3	21
Kalkaska	153	4	17.4	4	107	7	810	1	33.8	6	74.0	23
Missaukee	153	4	51.8	25	90	4	1,005	10	19.0	16	61.9	1
Montmorency	154	6	16.0	2	115	12	876	4	31.1	8	72.2	22
Clare	156	7	21.0	8	155	23	992	9	46.3	3	64.0	6
Newaygo	162	8	31.4	14	115	11	1,213	15	20.3	15	67.3	11
Gladwin	165	9	15.0	1	110	8	860	3	26.2	11	68.9	13
Leelanau	170	10	50.5	24	80	2	1,459	20	37.1	5	65.3	7
Mecosta	175	11	35.0	15	120	15	1,174	13	20.9	14	77.2	27
Ogemaw	175	11	22.9	10	163	27	921	5	26.6	10	66.0	9
Oceana	176	13	37.3	16	121	17	1,439	18	4.8	27	70.5	18
Antrim	180	14	21.7	9	110	9	975	8	28.9	9	68.7	12
Osceola	190	15	30.9	13	120	16	1,075	12	31.2	7	70.6	19
Van Buren	205	16	65.2	28	163	25	1,800	27	7.3	21	76.6	26
Montcalm	211	17	38.4	18	116	13	1,388	16	12.3	18	75.4	25
Arenac	212	18	19.1	6	111	10	956	7	40.1	4	66.[illegible]	10
Barry	213	19	42.8	21	123	19	1,551	21	13.5	17	78.0	28
Isabella	224	20	25.6	11	170	28	1,439	18	24.8	13	62.7	2
Allegan	225	21	55.0	26	101	6	1,620	24	6.6	24	63.4	4
Livingston	227	22	61.8	27	163	26	2,177	28	5.2	25	75.2	24
Tuscola	244	23	39.0	19	157	24	1,421	17	4.9	26	63.8	5
Hillsdale	256	24	66.1	29	151	22	1,582	23	8.4	20	79.0	29
Lapeer	258	25	44.7	22	117	14	1,621	25	12.0	19	71.1	20
Gratiot	270	26	38.1	17	137	21	1,625	26	6.7	23	70.0	17
Huron	273	27	48.0	23	179	29	1,570	22	7.1	22	62.9	3
Clinton	274	28	41.0	20	124	20	2,182	29	3.1	29	69.7	15
Sanilac	274	28	26.9	12	122	18	1,200	14	3.4	28	65.5	8

U. S. Census; (d) the percentage of farm families on relief, 1935, from the Michigan E. R. A. Monthly Bulletin of Public Relief Statistics, January 1935; and (e) the percentage of rural-farm children aged 14-17 attending school, 1930. These indices are intended to supplement one another. The first and third cover items directly affecting the farmer's comfort, but which are purchased for several years of use. The second covers cash expenditures for current needs. The last two are supplementary indices.

The general procedure was to work out rank correlations between each of these indices and the land ratings of the counties.[2] The various data are shown in Table 1 and the correlations obtained in Table 2. It is necessary to note that all the items except "percentage of farm families on relief" are ranked from lowest to highest. The reason for reversing the order of rank of relief data is perhaps clear. All the level of living indices but one show significant positive correlations with soil ratings for the 29 counties included in the table. The following paragraphs offer some interpretative comments.

The standard of living index is a composite rating based on several

[2] A rank correlation is a measure of the similarity of the ranks of two traits of each item (county) in their own series. Perfect positive relationship carries a value of 1.00, perfect inverse relationship a value of -1.00, and complete lack of relationship a value of zero. In the treatment of only 29 cases this method is probably as reliable as the more laborious Pearsonian coefficient of correlation.

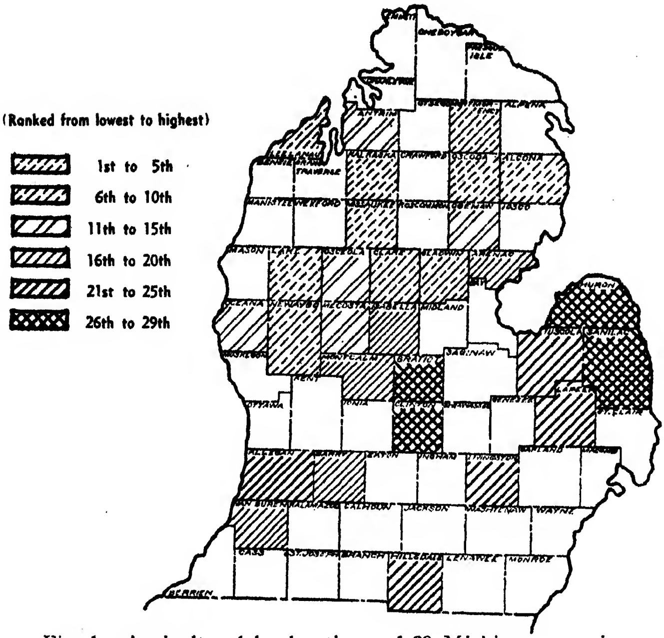

Fig. 1. Agricultural land ratings of 29 Michigan counties (ranked from lowest to highest).

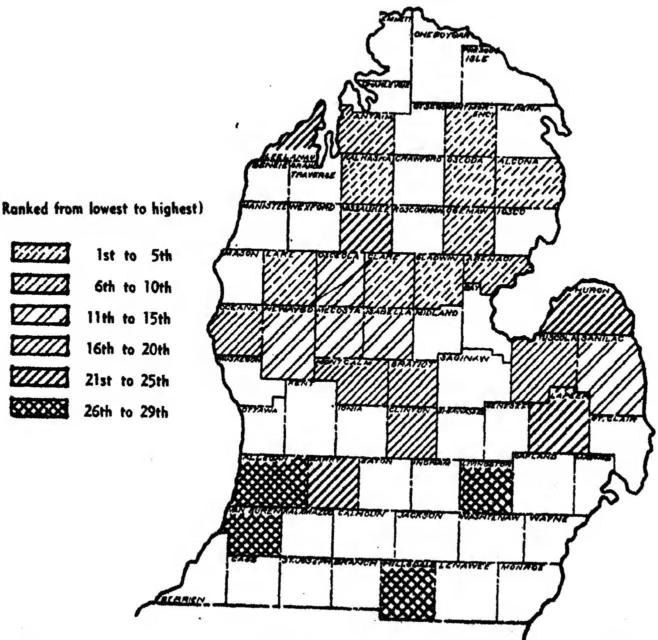

Fig. 2. Standard of living idex. Rural farm families, 29 Michigan counties, 1930 (ranked from lowest to highest).

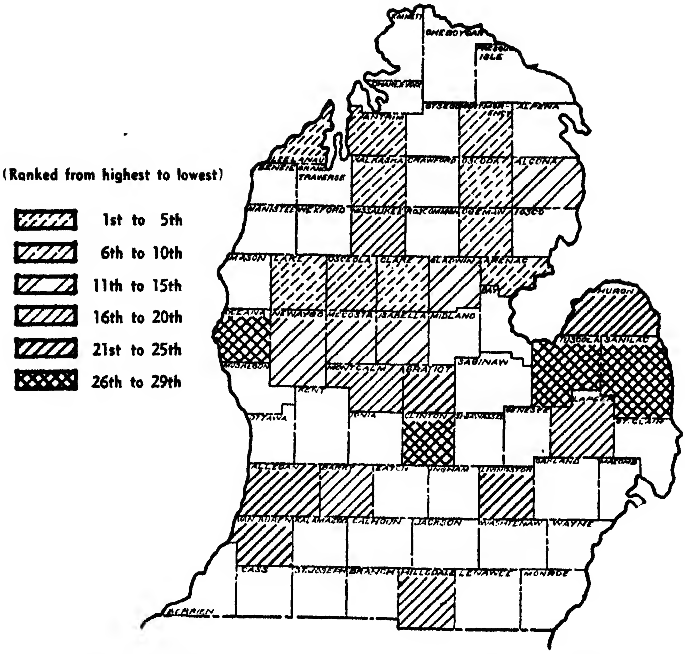

Fig. 3. Percentage of rural farm families on relief, 29 Michigan counties, 1935.

items as above noted. Though it covers only farm families, it is influenced greatly by the number of towns and cities scattered through the counties. The likelihood that farm families will have telephones or electricity or will live on an improved road, still depends largely on the density of population in their respective vicinities. Only when these factors of "settlement" are taken into account should we expect to find a close relation between the possession of these advantages and the farmer's income or the productivity of his land. Taking the influence of this variable into account, a correlation of .61 between the standard of living index and land ratings does give a tentative indication of the dependence of the former on the latter.

The item "retail sales per capita" shows a positive but irregular

Table 2. Rank correlations between soil ratings and level of livings indices: based on data for 29 Michigan counties.

Item Correlated with Land Rating	Correlation
Standard of Living Index	.61
Retail Sales Per Capita	.62
Average Value of Farm Dwelling	.75
Independence of Public Relief	.74
Percentage of Children Aged 14-17 at School	−.03

relation to land ratings. The correlation (+.62) is high enough to lend weight to the idea that soil conditions are an important factor in determining the welfare of the farm population. Several points of qualification about the data must, however, be made. First, the facts presented cover the whole county, not only the farm population. This means that if there is a wide spread between the farmers' levels of living and those of the non-farm families the figures given may not exactly represent those families directly dependent on the soil. A second point, and a more significant one, is that the data are based on retail sales made in the counties, not retail purchases made by the counties' inhabitants. The major source of discrepancy between these two is purchases through mail order catalogs. It is of course impossible to estimate accurately the extent of this sort of buying. Whenever urban markets are near at hand, they tend to compete with local shopping centers; and this kind of out-of-town buying must be added to the use of mail orders. It is the opinion of the writer that these limitations do not negate the value of this item so long as it is used as supplementary to other indices.

Very little can be said in interpretation of the relation of the value of farm dwellings to the soil conditions in the counties. The values given are the farmers' own estimates, so are only approximately correct. The correlation (+.75) is significantly high. A house represents savings accumulated over several years, and so indicates the farmer's success during an extended period of time. Though it is true that the fortunes of farmers rise and fall, and the value of one's house may reflect his well-being during an atypical period, the value and condition of a farmer's house is, as a rule, a good index of his long-term success.

Financial independence, as measured by relief loads, is one index of economic success. In 1935 there was a very close identity between the counties having poor land and those having large relief loads and *vice versa*. The willingness of different types of people to accept relief, and of relief administrators to give it is a differential that would have to be taken into account in a larger study. These factors are probably important in explaining deviations from the typical. However, it is the total picture, rather than that yielded by any two or three selected counties, that has significance in the analysis of any of the indices used in this study. Relief loads when used to measure the general welfare of the population do show that the areas of good soil are closely concomitant with the areas of economic sufficiency.

There is a complete lack of relationship between secondary school attendance and land ratings. Similarly there is no apparent relation between this item and the other level of living indices already discussed. Only one possible explanation of this exists, namely, the obtaining of secondary or higher education where the population of a whole county rather than the individual family is taken as the unit, depends on other factors than the financial ability of the families to provide it. The inclusion of school attendance as a measure of the level of living rests on a subjective basis—that is, it assumes its desirability to the population being studied. Beyond the level of the elementary grades this is not always the case. Peoples of unlike European backgrounds place widely different value on secondary schooling.

Let us compare briefly two pairs of counties. Kalkaska and Missau-

kee have the same soil rating. Three of our indices show the latter ranking much higher than the first. In contrast, 74 per cent of the children of high school age in Kalkaska county were attending school in 1930 whereas the corresponding figure for Missaukee is the lowest of any county studied, 61.9 per cent. The census reveals that Missaukee has 43.18 per cent foreign-born or born of foreign parents, while only 24.24 per cent of Kalkaska's population are of these types. The Kalkaska "foreign" population contains many nationalities while in Missaukee, Hollanders dominate. This difference in the ethnic composition of the two counties probably accounts for their differences in school attendance. Two other counties appearing contiguously on the list are Tuscola and Hillsdale, with 63.8 and 79.0 per cent, respectively, of children aged 14-17 in school. Hillsdale is only 12.14 percent foreign, whereas a large German population brings the percentage for Tuscola to 44.97. As a general rule, Germans of the class that migrated do not encourage higher education except in preparation for a very small number of professions. These two contrasts are given in evidence of the contention that cultural upbringing is often just as important as economic means in determining what level of education a given section of the population will attain.

The main lesson of this study is clear. Good land, when put to the use for which it is best adapted, will contribute significantly to the farmer's level of living. In the sense that a large volume of produce is dependent upon it, high quality farm land is a *prime requisite* of successful farming.

An examination of further data, however, leaves a strong impression that other factors are also important. The tables show that there is not an exact relation between the farmer's well-being and the quality of his land. Arenac county, with a land rating well above average, has a comparatively low level of living. Livingston county, in contrast, stands higher in every other rating than it does in soil. Van Buren county ranks among the most prosperous, yet has soil of only average quality. Only tentative explanations of these differences can be given here.

The proximity of a farm to lines of communication and to markets is of prime importance. The human being lives in a man-to-man as well as a man-land relationship. His welfare depends on his niche in a broad division of labor, and on the economic return he can command for his goods or services. The farmer's cash income is affected by the cost of transporting his produce to market. The relative prosperity of Livingston and Van Buren counties is unquestionably tied up with their respective closeness to the Detroit, Benton Harbor and Kalamazoo markets. In contrast, farmers in the upper part of the state lose through having to pay heavy transportation costs before their produce is marketed. Location, in relation to transportation facilities and markets, appears very important in determining the desirability of a given farming area.

The soundness of farming practices is another variable among producers. Farmers are not equally resourceful in getting the same type of land to yield a good crop. Such factors as the selection of the right crop for the soil, the proper use of fertilizers, and the use of farm machinery, affect the productivity of the land. The knowledge of, and

the readiness to adopt sound farm practices is often affected by the hardening of custom and the fear of experimentation.

Another possible contributory factor affecting the differences between land ratings and the farmers' levels of living may be the tendency for some population groups to spend a larger percentage of their incomes for "consumers' goods" than others. The extent to which this is a factor cannot be stated.

These points are not intended to minimize the importance of good land, but rather to show that land is only one of a complex of factors which together determine what measure of physical comfort the farmer is able to enjoy. The fact remains, however, that there cannot be a high return from agricultural enterprise unless the produce per acre, relative to the capital and labor expended on it, is high. Therein lies the importance of good land.

CYANAMID AS AN ORCHARD FERTILIZER

F. N. HEWETSON
SECTION OF HORTICULTURE

In the spring of 1934, many growers in Michigan using Cyanamid as their nitrogenous fertilizer applied it somewhat later than was advised by the manufacturers. By early summer they noticed that the trees fertilized with Cyanamid were developing abnormalities in leaf color. Leaves were turning brown at the tips and edges, then yellow, and in severe cases the trees became partially or entirely defoliated. This situation caused considerable worry to the grower as it was feared that such defoliation might cause permanent injury to the trees.

Experimental

A survey and description was made of this injury (1) and as a result, a number of plots were laid out in the various fruit growing sections of Michigan. These plots were laid out to include various commercial tree fruits with the object of studying the best method of handling Cyanamid in Michigan orchards. Detailed descriptions of the various fertilizer treatments have already been reported (2). Briefly, they consisted of Cyanamid applied in the early and late fall and in the spring, and, as a comparison, sulphate of ammonia applied to adjacent plots in the spring. Phosphate and potash fertilizers were also used on some of these plots to find out if they would counteract the burning effect of Cyanamid. Apples, pears, peaches, plums, and cherries were subjected to these treatments in soils ranging from sand to clay, sand and sandy loams being the predominant soil types on which Michigan fruit trees are grown.

Observations in 1935

The season of 1935, the first year of the experiment, provided good growing conditions for all the trees and no differences regarding tree

growth and general condition of the trees could be observed as a result of fertilizer treatments, except in two plots in Grand Traverse county. In one of these plots the leaves were observed to be darker and slightly larger on the fall-fertilized than on the spring-fertilized trees receiving Cyanamid. In the other instance, the trees produced a heavier crop of larger and better colored fruit on the fall-fertilized plot than on the spring-fertilized Cyanamid plot.

Observations in 1936

Growing conditions in 1936 were not favorable for best results with Cyanamid, the soil becoming very dry as the season progressed. The effect of these conditions was reflected in the behavior of the trees to the various fertilizers to a marked degree.

All of the apple and pear trees receiving Cyanamid and sulphate of ammonia made satisfactory growth and maintained a healthy foliage throughout the season. These trees were grown on soils ranging from a sandy to a clay soil. Some were grown under clean cultivation, while others were grown under sod. The sod in one plot of apple trees receiving a spring application of Cyanamid was slightly burned but soon recovered and no permanent harm resulted. The one block of plum trees also made satisfactory growth irrespective of treatment.

Cherry and peach trees responded in a somewhat different manner to these fertilizer treatments. Of the 13 blocks of cherries in the experiment, seven blocks developed foliage injury to a greater or less extent. An analysis of these injuries showed that they all developed on trees receiving the spring applications of Cyanamid, and all on the trees which were grown on a sandy soil. Although potash had been applied to some of these plots with the hope that it might prevent burning of the foliage no such effects were obtained, and plots to which potash had been applied were just as much affected as those which received Cyanamid alone. The same negative response resulted from the use of phosphate. No injury developed on trees receiving a fall application of Cyanamid.

With the peach trees, every fertilizer plot showed some burning in the spring Cyanamid block with or without an additional application of potash or phosphate. Four of these blocks were on a sandy or sandy loam soil while the fifth was on a heavier soil type. In this fifth block the trees were not injured so much as those in the other four blocks, so that they soon recovered from the initial leaf burn. While these applications were comparable to regular fertilizer practices, it was thought desirable to study the effect of doubling the amount of Cyanamid applied in the spring. Two plots were given this double treatment. As was to be expected, this treatment resulted in considerable burning of the leaves and subsequent defoliation. In one of these plots the defoliation resulted in fewer fruit buds the following year. In the other plot, on a slightly heavier soil, the trees appeared normal the following year. As in the cherry, no sign of injury could be observed with fall applications of Cyanamid, and trees on these plots made good growth.

Chance observations made during the summer of 1935 brought to light two cases of foliage injury in cherry orchards. In these cases, Cyanamid had been applied by the growers in the late spring of that

year. In both cases the trees were grown on a sandy soil. Investigations showed that these growers had waited till spring, and then, in the rush of work had delayed making the applications until too late. No harmful effects from this instance of severe defoliation could be observed the following year.

Observations in 1937

No ill effects were observed from fall or spring applications of Cyanamid during the 1937 season, on any of these trees in the experiment. This was a year of comparatively high moisture during the early part of the season and one which was satisfactory for spring applications of Cyanamid.

Discussion

In summing up the work of these three years on the use of Cyanamid in orchard fertilization, we find that no injury developed on apple, pear, and plum trees receiving either fall or spring applications or cherries and peaches receiving fall applications of this material. Also, no injury developed on the heavier types of soils. When applied to cherries and peaches in the spring, however, Cyanamid produced leaf burning and sometimes defoliation of the tree, when the ground was too dry for proper absorption of this fertilizer. Trees which had been severely injured in 1934 showed no serious after effects when given proper subsequent care.

A detailed discussion of these results would lead us into too many technicalities. Suffice it to say that Cyanamid requires adequate moisture and sufficient organic matter in the soil in order to convert its nitrogen into a form which may be absorbed by the tree and will not prove toxic to it. Cherry and peach trees are generally considered to be more susceptible to adverse environmental conditions than are apple and pear trees. If sufficient time has not elapsed between the time of application and the beginning of growth in the spring, some of this Cyanamid will be absorbed in a toxic form and so produce typical Cyanamid injury. This change in the form of nitrogen is hastened by having adequate moisture and organic matter in the soil. To insure the necessary moisture, fall applications made in September or early October after growth has ceased and before the ground has frozen are to be advised.

If applied after the ground has frozen, Cyanamid will not become incorporated into the soil and may absorb carbon dioxide from the air, producing toxic substances. In the spring these will be absorbed by the soil and may prove harmful to the tree. A soil-building program will help provide some of the necessary organic matter and will insure optimum results from the use of Cyanamid in addition to the many other advantages to be derived from such a policy.

As well as time of application, even distribution of the material is necessary in order to avoid too great an absorption of the fertilizer in a limited root area. Too great a concentration in one spot is equivalent to a heavier application which, as has been pointed out, may lead to very undesirable results.

With all these precautions necessary for success with Cyanamid, it may seem foolish to use it. However, Cyanamid has certain peculiar

properties which are well worth this little extra care. First, it contains the equivalent of 70-per cent hydrated lime. Though this amount, on the basis of 250 pounds of Cyanamid per acre, is not large, it does help to counteract the acidifying action produced by previous applications of sulphate of ammonia or similar acid fertilizers used over a long period of time. In cases where such cover crops as alfalfa or sweet clover are being grown in the orchard, this lime content will help to sweeten the soil and so provide better growing conditions for these plants. Second, its physical properties make Cyanamid a very desirable fertilizer to handle and distribute. A regular seeder may be used with very good results, and an even distribution is assured. Third, the very features of Cyanamid which may cause trouble under adverse conditions are greatly in its favor if properly handled. Because the nitrogen in Cyanamid, though not so readily available to the plant as that in some fertilizers, is also not so readily leached away, it may be held in the soil for a considerable time and gradually changed into a form which may be taken up by the plant. Thus when the trees are fertilized in the fall, the nitrogen is gradually absorbed by the roots and held there until needed to produce new shoot growth in the following spring.

Conclusions

On the basis of this work, it may be concluded that Cyanamid when applied in the fall under adequate moisture conditions before the ground has frozen and distributed evenly at rates advised by the manufacturers, will produce results comparable with other standard fertilizers. It may be applied with apparent safety to apple and pear trees in the early spring 3-4 weeks before growth starts if adequate moisture conditions prevail. It is **not** advisable to apply this fertilizer to cherries and peaches on sandy soils in the spring for reasons already discussed.

Citations

1. Cardinell, H. A. and Gray, G. F. Defoliation from the use of Calcium Cyanamid. Mich. Agr. Exp. Sta. Quart. Bul. Vol. 17, **3:** 101-105. Feb. 1935.
2. Gray, G. F. Observations in 1935 on the use of Calcium Cyanamid in orchards. Mich. Agr. Exp. Sta. Quart. Bul. Vol. 18, **3:** 170-172. Feb. 1936.

WILD OATS OR DOWNY BROME

Troublesome Weed on Sandy Land

C. R. MEGEE
FARM CROPS SECTION

Downy bromegrass *(Bromus tectorum, L.)* also called Slender Chess, and Early Chess and frequently spoken of in Michigan as wild oats, spreads rapidly in alfalfa fields, fence rows, and waste places—especially on sandy soil. This pest is not the wild oats of the northwest, nor

should it be confused with the very valuable, productive and palatable smooth brome *(Bromus inermis, Leyss)* which is meeting with favor for pasture and hay when seeded with alfalfa. Most downy brome plants behave as winter annuals, the seed germinating during late August and in September when the fall rains start, and the plants live over the winter and mature their seeds just before growers harvest the first alfalfa crop. The plants are very winter-hardy and seed production is very prolific.

Downy bromegrass was seeded on some test plots at various times of the year to determine the behavior of the plants and the influence of the time of germination of seed upon seed production. The behavior of the plants is shown in the accompanying table:

Time Seedlings Started	Growth Following Spring	Seed Production
April to June	Luxuriant	Heavy
Summer	Seed did not germinate	
September to October 15	Luxuriant	Heavy
November 1 to January 1	Very slight	Very slight

A few plants behaved as annuals, though the number producing seed the same season the seed is sown would hardly be sufficient to produce a serious infestation. Seeds failed to germinate during mid-summer, partially because of dry weather and partially because the seed produced during the late spring usually goes through a rest period before it germinates. It is the seedlings that become established during early fall that produce an abundance of seed.

There are no well-established methods for controlling downy bromegrass other than clean cultivation. Each of the following suggestions for control have been used with some degree of success, but each has its limitations and drawbacks. Possibly a combination of two or more methods might prove to be desirable.

Clean Cultivation

Since downy brome is an annual or winter annual and propagates by seed only it can easily be controlled on cultivated land. The seed is produced the season after the seedlings start, consequently, late fall cultivation or early spring cultivation or plowing will destroy the seedlings and prevent seed production. The plants should be destroyed by the time they reach the early blossom stage. If allowed to develop further there is danger of seed production. The plow, the disk harrow and the spring-toothed harrow are effective for controlling downy bromegrass.

Spring Grazing

Downy brome plants are very unpalatable to livestock except in the seedling stage. While conducting alfalfa pasture trials at the Kellogg Demonstration Farm at Augusta, H. C. Rather of the Farm Crops Section, observed that the alfalfa plots grazed during late April and

the first half of May were almost entirely free of downy brome. Plots that were not grazed until May 15 or later were badly infested. Alfalfa plots grazed during September became almost entirely downy brome. The alfalfa was greatly injured by the September pasturing and this gave the downy brome an opportunity to spread throughout the plot and take possession of the land.

Alfalfa-Grass Mixtures and Alfalfa Management

The thicker the stand of alfalfa and the denser the bottom growth the more difficult it is for downy bromegrass seedlings to become established. Smooth bromegrass is drouth-resistant and makes a relatively good growth during July, August, and early September, and is an excellent grass to mix with alfalfa. Timothy is also valuable to mix with alfalfa, although it does not form so dense a sod nor produce so much growth during August as does the smooth brome. Other practices which assist in preserving the stand and vigor of alfalfa and in keeping out the downy brome are: (1) Cutting twice instead of three times a year; (2) cutting early not more than once during the season, and (3) not cutting or grazing heavily during September. Also when establishing a seeding of alfalfa only winter-hardy strains such as Hardigan and Grimm or the most winter-hardy common should be used. Often a fertilizer containing potash is of value on sandy soil.

Spring Cultivation Before and After Growth Starts

Downy bromegrass starts growth early in the spring and the fibrous roots mat together, forming a dense sod for a winter annual plant. Spring cultivation just before or as the alfalfa starts to grow is not usually successful in checking downy brome. The plants are held together by the matted roots and the spring rains usually settle the mat back on the ground so that growth is soon resumed. If more than one cultivation can be given and the ground is dry enough to work the downy bromegrass plants apart and leave the roots exposed, some progress is likely to be made toward reducing the stand of downy brome. Often weather conditions are more favorable and a more thorough cultivation can be given after the alfalfa has started growth. The cultivation may delay the time of cutting the first crop of hay but should not injure the stand of alfalfa.

Early Cutting of Alfalfa

Downy bromegrass matures at least a week or 10 days before the usual time of cutting the first crop of alfalfa hay. At this time mature seeds shatter easily and an abundant crop of seed is left on the ground to germinate and produce seedlings when the fall rains start about the first of September. Downy bromegrass seed germinates less than 50 per cent when it has reached the dough stage. It is a good practice to cut the alfalfa when the earliest maturing downy bromegrass seeds have reached the early dough stage. This very greatly reduces the amount of downy bromegrass seeds that will germinate and prevents the shattering of the seeds on the alfalfa field. This is earlier than the alfalfa should be cut consistently. The next cutting of alfalfa should be allowed to reach approximately the full bloom stage in order to prevent injury.

Fall Cultivation

Downy brome plants not well established by the latter part of October produced very little seed the next season in the test plots. Two or more cultivations during the late fall if weather conditions permit, should work a considerable amount of the dirt from among the fibrous roots and leave the plants exposed to the freezing of the winter weather. If only one cultivation is made or the soil is moist when the cultivation is made and the soil adheres to the roots, but little will be accomplished toward eradication.

TWO MORE HYBRID CORNS PROVE VALUABLE IN MICHIGAN

A. R. MARSTON AND R. E. DECKER
SECTION OF FARM CROPS

Since 1936 there has been available to farmers of southern Michigan, a top-crossed hybrid corn variety known as Michigan No. 561.[1] This hybrid, developed by the Michigan Agricultural Experiment Station, has given a good account of itself for grain production on the more fertile soils of southern Michigan and farmers report satisfaction with it for silage as far north as the Thumb district. Since the best performance of Michigan No. 561 has been in Monroe county on good soils and in a section which has the warmest and longest corn-growing season in the state, it is to be expected that the adaptation of this strain for grain production is more or less limited to localities of similar soil and climate.

Over-state trials which have been carried on for the last three seasons have revealed two additional hybrids, Michigan No. 1218 and Minnesota No. 402, as being superior in performance under conditions demanding an earlier corn than No. 561.

Michigan No. 1218 is another top-crossed hybrid. The female parent used in making the cross from which the seed ears are harvested is an old standard Michigan variety, Pickett yellow dent. The strain of Pickett being used for this combination is one which has been grown for several seasons by R. V. Tanner of Jackson, Mich.

To make Hybrid No. 1218, Tanner's Pickett corn is pollinated with a Michigan inbred, No. 1459. Several years ago a cross was made at this station between Maize Amargo and Red Cob Ensilage, two very late varieties. The next season some first generation plants from this cross were pollinated with Wisconsin No. 25, a very early yellow dent.

With this combination, inbreeding and selection were carried on for six generations, resulting in the development of inbred line No. 1459.

The crossing of inbred No. 1459 on Pickett corn, to produce Hybrid No. 1218, has given a corn slightly earlier in maturity than its Pickett parent and a substantially better producer of both grain and silage.

[1]Ref. Mich. Agr. Exp. Sta. Quart. Bul., Vol. 18, 4. May, 1936.

Table 1. Michigan hybrid No. 1218 compared to commercial corn varieties in Saginaw Valley tests.

*Average of three years' tests

Corn Strain	Moisture Per cent at Harvest	Yield of Silage (Tons per Acre)	Grain Yield at 14 Per cent Moisture (Bushels)
Michigan Hybrid No. 1218	30.67	10.56	70.11
M. A. C. Yellow Dent	34.72	8.02	58.24
Pickett Yellow Dent	35.86	7.98	55.35
Golden Glow	32.56	8.47	54.00

*Average of 5 replications, random distribution in 1935, 1936 and 1937.

Table No. 1 shows that Michigan Hybrid No. 1218 produced 25 per cent more corn per acre than any of the commercial varieties with which it was tested. In 1935, a test of this strain was also conducted in Huron county. In this test, Hybrid No. 1218 produced more than 15 per cent more corn per acre than Pickett yellow dent which was of essentially the same maturity. Those sections of the state which have normally matured Pickett or Golden Glow corn should find Hybrid No. 1218 satisfactory for grain production and a better yielder than either.

The earliest of the hybrids tested thus far has been one originated by the Minnesota Experiment Station, designated as Minnesota Hybrid No. 402. This hybrid is a cross between two Rustler inbreds and a single cross of early Minnesota No. 13 inbred lines. This double cross hybrid produces corn that is mixed in color, having both white and yellow kernels on the ear. In both the Otsego and Wexford county trials, it has produced considerably more corn than the usual commercial corn varieties grown in the north.

Minnesota hybrid No. 402 has been grown on a field scale by several growers in the areas in which these tests were conducted, giving them more ripe corn than varieties which they had formerly grown. P. R.

Table 2. Comparison of Minnhybrid No. 402 and the recommended commercial varieties for Wexford and Otsego counties.

*Average of three years' tests

Corn Strain	Wexford County			Otsego County		
	Moisture Per cent at Harvest	Yield of Silage (Tons per Acre)	Grain Yield at 14 Per cent Moisture (Bushels)	Moisture Per cent at Harvest	Yield of Silage (Tons per Acre)	Grain Yield at 14 Per cent Moisture (Bushels)
Minnhybrid No. 402	43.63	5.59	36.15	41.58	9.31	50.98
Northwestern Dent	41.16	4.76	25.66	40.78	9.05	38.39
Golden Glow (Crandell)	....	....	....	51.75	9.94	39.57

*Average of 5 replications, random distribution in 1935, 1936 and 1937.

Biebesheimer, county agent of Wexford county, reported that one of his growers of Minnesota No. 402, obtained 97 crates per acre with the hybrid, while his own commercial variety produced some 60 baskets per acre.

The objection has been raised that Minnesota No. 402 did not produce so much fodder as Golden Glow, for example. It is true that this hybrid does not grow as tall as Golden Glow, but this slight difference is more than off-set by the increased grain yield. In fact, it has been equal to Golden Glow in tons of silage per acre and, with 10 extra bushels of grain, its silage must be superior in quality. Minnesota No. 402 has consistently out-yielded Golden Glow and similar commercial open-pollinated varieties as far south as Saginaw, although in central Michigan, the hybrid No. 1218 has been superior to No. 402.

In the trials on which the foregoing conclusions are based, each variety was planted in three-row plots and was included in each test in five different plots located at random. Besides these comparisons, a number of hybrid corn demonstration plots have been put out in cooperation with Smith-Hughes agricultural students and teachers further to work out the merit and adaptation of each line. In these field trials, Minnesota No. 402 has fully lived up to its promise of superiority in northern Michigan, while Michigan No. 1218 has led in central Michigan trials and as far south as Jackson county.

In a state where soil and climatic conditions are as variable as those in Michigan, it is difficult to map out the adaptation of any corn variety. There is a limited area, including parts of both Lenawee and Hillsdale counties, which requires an earlier corn than is needed in Monroe at the same latitude. On the other hand, Traverse City and similar northern locations near the Lake Michigan influence have a frost-free season as long as that of inland areas much farther south.

In general, the three corn hybrids of demonstrated worth in Michigan have the following range of adaptation:

Michigan Hybrid No. 561—For grain in the more favorable soil and climatic environments of the southern tier of Michigan counties; for silage, as far north as Saginaw.

Michigan Hybrid No. 1218—For grain in southern Michigan locations requiring an early maturing corn and on north to the Saginaw Valley and Thumb district. It should prove satisfactory for silage somewhat farther north.

Minnesota Hybrid No. 402—For grain, silage and fodder in all northern locations now growing corn in the lower peninsula.

IMPROVING THE QUALITY AND YIELD OF MICHIGAN MALTING BARLEYS

J. W. THAYER, JR.
SECTION OF FARM CROPS

As the 1936 crop of barley from the Thumb district of Michigan entered commercial channels, it became evident that there was a distinct difference in quality between the barley shipped from points in the eastern side of this region as compared with that originating on the west side, nearer Saginaw Bay. Buyers contended that the crop from the east side contained too many blue kernels (kernels that are steely in character and have a bluish color), and that the color of the grain as a whole was poor. Barley shippers reported that, for the 1936 crop, maltsters readily paid 10 to 15 cents per bushel more for barley grown in the western portions of the Thumb than for that produced on the eastern side.

To determine how the samples of barley from these two areas differed and the cause of that difference, a representative of the Farm Crops Section of the Michigan Agricultural Experiment Station made a tour around the Thumb and collected samples of barley from farms along the way. In this manner 79 samples, which might be classed as malting barley, were obtained and returned to the college for analysis.

In the laboratory, these samples were classified as to their color, plumpness, test weight, purity, skinned and broken kernels, and texture. These are factors which are used to determine commercial grades of malting barley.

The 79 samples studied consisted of 37 samples of Wisconsin No. 38, 39 samples of six-row rough-awn type, and 3 samples of Velvet. It is significant to note the distribution of these varieties in the district covered and the direct relation between them and the complaints received in the season of 1936. In Sanilac county on the eastern side of the Thumb, the three samples of Wisconsin No. 38 averaged 0.3 per cent blue kernels while the 23 samples of six-row, rough-awn barley averaged 37 per cent blue kernels. As this high percentage of blue kernels is not apparent in the rough-awned barley types on the western side of the Thumb district, it becomes apparent that the barley being grown on the eastern side of the district consists of a mixture of white and blue barley types and is not of pure Oderbrucker type. Growers of that section should find it advantageous to replace seed stocks of their rough-awned barley with pure seed of the variety Wisconsin No. 38. Although the Wisconsin No. 38 samples were not free from blue kernels, the percentage of this type was so low in all instances as to be unimportant and may have been due to slight mixtures.

A good bright color is the first requirement for malting barley. The grain color of the samples varied from bright to badly weathered but little relationship existed between sample color and section of

Table 1. County of origin, variety, and average percentage of steely (blue) kernels.

County	Number of Samples	Variety	Average Per cent Steely
Huron—East	4	Wisconsin No. 38	0.5
Huron—East	4	Rough six-row	31.5
Huron—Central	6	Wisconsin No. 38	2.0
Huron—Central	2	Rough six-row	18.0
Huron—West	10	Wisconsin No. 38	1.0
Huron—West	2	Rough six-row	2.5
Sanilac	3	Wisconsin No. 38	0.3
Sanilac	23	Rough six-row	37.0
St. Clair	4	Wisconsin No. 38	2.7
St. Clair	1	Velvet	0.0
St. Clair	3	Rough six-row	21.3
Saginaw	2	Velvet	0.0
Saginaw	4	Rough six-row	0.7
Tuscola	10	Wisconsin No. 38	1.3
Tuscola	1	Rough six-row	0.0

origin. Grain color is not a factor which can be controlled entirely by the farmer but often the difference between barley which qualifies for the premium malting prices and that which is not acceptable depends upon the manner in which the grain is handled. Well-made shocks, rather than piles made with a fork, often protect the grain from weather and ground damage and make the difference between good and poor color. Grain in well-made shocks dries out quickly and may often be threshed sooner than that which has been piled with a fork.

Plumpness of kernel, a factor largely governed by growing conditions and soil fertility, varied only slightly between samples. Of the 79 samples, 69 were classified as plump, 8 as slightly shrivelled, and 2 as badly shrivelled. Plumpness of kernel influences test weight but the latter factor is affected greatly by the amount of beard attached to the kernel and the amount of trash in the sample. The 79 samples, as they came from the farm, had an average test weight of 40 pounds and a range of 34 to 48 pounds per bushel.

Threshing, a factor which the farmer can control, has a great influence upon the quality of the barley from the maltster's viewpoint. In the malting process, skinned and broken kernels do not germinate and grow the same as whole kernels with the hull intact. In addition, they lower the yield of malt. Threshing should be done with the concaves so set and the speed of the machine so regulated that the awns are broken off close to the tip of the kernel but the hull should not be peeled from the kernels nor the kernels broken. The material under consideration was classified as follows: 26 samples properly threshed, 19 slightly damaged, and 35 seriously damaged by threshing too close.

Only 16 of the samples collected were free from foreign material, 39 had a trace of oats, and 24 contained larger amounts of oats. Four samples had a trace of wheat and 5 had wheat in larger amounts. Many samples had other foreign material which would detract from the grade. Purity is a factor over which the farmer has a large measure of control and one which is very important in determining the quality of the

Table 2. Comparative yields of commercial barley varieties at East Lansing, Mich.

Variety	Yield in Bushels per Acre				
	1934	1935	1936	1937	Average
Wisconsin No. 38	35.9	45.8	43.0	25.1	37.4
Spartan	27.5	48.1	34.2	27.0	34.2
Velvet	29.6	37.5	36.7	27.8	32.9
Pliter	27.4	40.0	34.6	23.3	31.4
Oderbrucker	27.5	25.6	31.8	20.2	26.3

product. Pure seed, planted on clean land, and kept free from mixtures will pay dividends in the larger returns received for the crop.

Texture of kernel is a factor which is of vital importance to the maltster because it influences the time required for the malting process, the uniformity of conversion, and the yield of malt. The maltsters want a soft mellow kernel which absorbs water freely, sprouts evenly, and grows quickly rather than a steely kernel which absorbs water slowly, sprouts unevenly, and grows slowly. The character of the kernel is influenced by weather, soil conditions, and variety. The farmer cannot control the growing conditions, but he can select a variety which is most likely to produce a desirable product.

Yield figures were obtained wherever possible, but are not reported here because the samples were not grown under comparable conditions or measured by identical methods. For this reason, yield comparisons as obtained from variety trials at the East Lansing station are shown in Table 2. It is significant to note that Wisconsin No. 38, on the average, out-yields the rough-awn, six-row type, Oderbrucker, by more than 10 bushels per acre.

The results of this study indicate that both the quality and yield of Michigan malting barley can be improved by the growing and proper handling of an acceptable standard variety such as Wisconsin No. 38: its smooth awns make proper shocking more likely; its low percentage of blue kernels make it desirable for the maltster, and last, but by no means least, its greater yielding ability makes it more profitable to the grower.

RATE OF SEEDING FOR BARLEY

J. W. THAYER, Jr.
Section of Farm Crops

How much barley should be sown per acre? What is the effect of different rates of seeding upon the plant, the quality of the grain and the total yield? Should all varieties of barley be sown at the same rate to obtain maximum yield?

To answer these questions, tests were conducted from 1932-1935 on the Michigan State College farm at East Lansing, involving six

rates of seeding, ½, 1, 1½, 2, 2½, and 3 bushels per acre for each of the following four varieties: Wisconsin No. 38, and Glabron, six-row types; and Spartan and Michigan Two-Row, two-row types. These tests were planted on a Conover to Hillsdale loam soil that received a 200-pound application of 2-16-2 fertilizer before planting.

Results of these tests showed that rate of seeding materially affected the plant characters: tillering, straw length and strength, head length, number of kernels per head, and size of kernel. In general, the four varieties reacted the same but they showed inherent differencs in the characters themselves. Seasonal conditions caused considerable variation in the expression of all plant characters.

All varieties tillered most at the ½-bushel rate of seeding and progressively less as the rate was increased to 3 bushels per acre. At all rates, the two-rowed varieties tillered more abundantly than the six-rowed.

The diameter and the length of the straw of all varieties decreased as the seeding rate increased. Although lodging was not a problem at any time during the test, the plots seeded at the heavy rates, 2, 2½, and 3 bushels per acre, had a decidedly smaller straw and showed more tendency to lodge than did those sowed at the light rates. Spartan always appeared to have the stiffest straw, while Wisconsin No. 38 and Michigan Two-Row showed tendencies toward weak straw.

Head length, on the average for all varieties, decreased approximately 40 per cent as the rate of seeding increased from ½ to 3 bushels per acre.

The number of kernels per head was found to be directly proportional to the length of head. The size of kernel decreased, on the average, 14 per cent as the rate of seeding was increased from ½ to 3 bushels per acre. A small kerneled grain of good weight is desired by the maltsters and so, under certain conditions, heavy seeding might be desirable for this reason.

Due to the fact that the test in 1932 was of a preliminary nature, the yield results for the three-year period, 1933 to 1935, only, are given in the table. The yields are reported as net yields (total yield minus seed planted). The results show that for maximum yields, the four varieties tested should not be planted at the same rate. Wisconsin No. 38, a small-seeded variety produced its maximum yield when seeded

Table 1. Net yield (total less seed) in bushels per acre, three-year average.

Variety	Rate					
	½	1	1½	2	2½	3
Wisconsin No. 38	22.3	31.3	29.8	30.4	30.3	27.2
Michigan Two-Row	23.5	29.7	31.7	30.3	30.6	29.2
Spartan	16.4	23.0	25.0	26.3	28.4	27.2
Glabron	25.0	26.2	27.8	25.9	26.9	25.3

Note: A more detailed presentation of the results of these experiments is presented in the Journal of the American Society of Agronomy, 29, (9) September, 1937, "The Influence of Rate of Seeding Upon Certain Plant Characters in Barley", by J. W. Thayer, Jr., and H. C. Rather.

at one bushel per acre, whereas Spartan, a large-seeded variety, had to be seeded at 2½ bushels per acre in order to give maximum yields.

For all varieties, ½ bushel per acre was too light and 3 bushels was too heavy to obtain maximum net yields. These tests indicate that seeding small-seeded varieties of barley at more than 1½ bushels per acre is wasteful of seed and may reduce yield, reduce the size of kernels, and increase the tendency of the barley to go down, and that seeding large-seeded strains below two bushels per acre is lessening the chance of obtaining maximum net yields.

LAMINATED RAFTERS FOR FARM BUILDINGS

Provide Clear Storage Space and May Be Reinforced With Cable to Prevent Sagging

H. H. MUSSELMAN
Section of Agricultural Engineering

The laminated rafter is made up of a number of layers of narrow boards bent to the desired curvature and nailed together. Their use to form the pointed arch or round roof offers several advantages which will be discussed in this article. They are most useful in constructing barns and implement barns where unobstructed storage space is desired. A brief of past and present needs may serve to show the reasons for more widespread adoption of the laminated rafter type of construction.

Barns built in earlier days were built with heavy square timbers framed together to obtain strength. Gable roofs were commonly used. To obtain stability it was necessary to cross the storage space in the barn with the timbers, and the gable roof was low. With improved mechanical hay handling equipment considerable inconvenience was experienced in getting hay in and out of the barn. This type of structure was followed by the plank or balloon frame with gambrel roof, self-supporting in many instances. Improvement in storage space was obtained but not without considerable expense for both material and labor in construction.

The typical early barn also had one or two driveways between the framed bents. Though useful in various ways, principally for storing bundle grain in the mow before threshing, much of the storage space above the drives was lost. In barns being built at the present time the tendency is to eliminate drives and obstructing frame-work and make use of the maximum volume of storage space.

For the newer type barn, therefore, the laminated rafter method which supplants timber and plank framing has many advantages. The material may be cut from native trees of smaller size and used rough-sawed which makes for economy. The system of laying out and construction is simple, since the rafters are made in multiple in a single

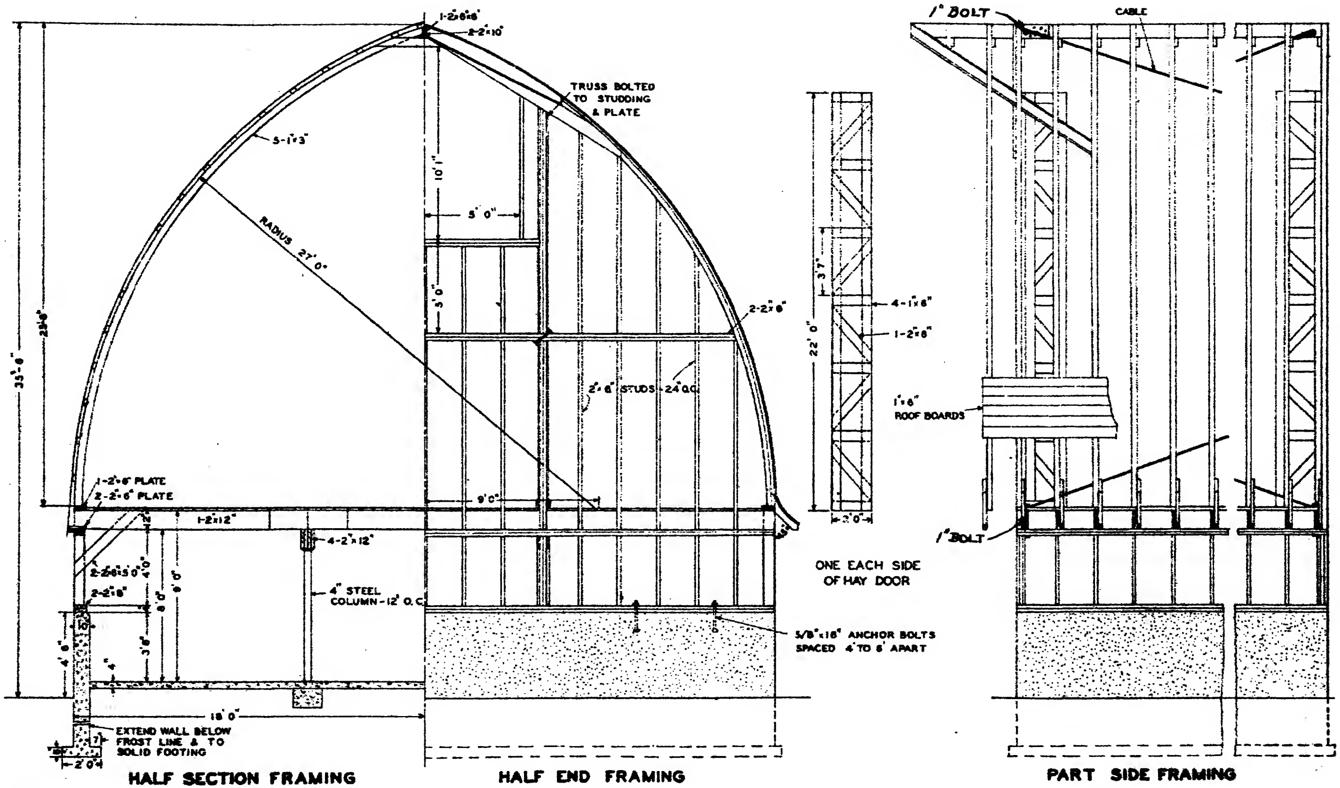

Fig. 1. Drawing showing essentials of laminated rafter construction. Right side of end shows lookout detail. Left side construction with lookouts omitted. Absence of lookouts permits use of metal roofing without excessive bending.

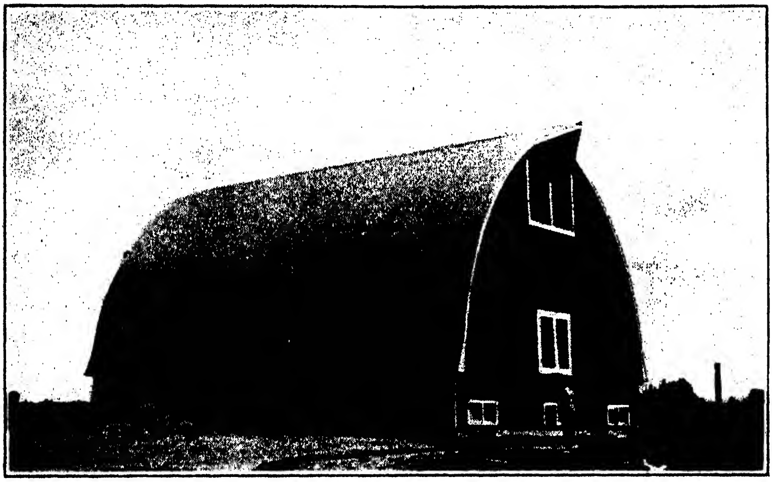

Fig. 2. Laminated rafter construction similar to drawing shown used in this barn. Built in 1934. Rafters are of spruce full 1-inch thick, five laminations.

form. Little skilled work is required, except for laying out and erection. The form of the roof, round or pointed arch, makes it resistant to wind. The storage space is entirely free from obstructing timbers and the volume of storage which can be obtained in a barn with single length rafters starting from the floor above the animals is sufficient to store roughage and bedding for these animals.

With the entire floor and storage space used for animal shelter and feed storage, it may be desirable to provide room for the few operations, once done on the barn floor, and machinery storage in a separate building. Laminated rafter, round roof construction provides separate space at low cost.

Roof Reinforcing

The elasticity of material which permits construction of the curved rafter also permits sagging of the roof-line unless the units in the construction system are tied together to obtain rigidity. From a mechanics standpoint the upper structure of the barn may be considered as a shell having rigid ends to which the curved roof sheet (rafters, purlins and roofing) is attached. Joining the ends at the highest point is the heavy ridge used in this construction. Ends, ridge, and roof-sheet are securely tied together and to the foundation to form a strong shell. To give added strength and insure against sagging, a system of cable reinforcing has been devised. In this development the ends of the ridge and the lower corners of the structure at the plate are considered as fixed points. Any sagging of the ridge in the center will be downward, which would force the rafters outward at a lower point. A cable (inextensible) is attached to the ridge at one end and to the sill at the opposite end. It is also wired to the rafters and strung tightly. Any outward movement of the rafter and corresponding downward movement of the ridge will therefore be resisted by the cable,

which is tight, inextensible and rigged to approximate the arc of a circle with the ends fixed.

Tests On Cable Reinforcing

Before using the cable system on a full-sized structure the principle was tested on a one-sixth size implement barn constructed exactly like the full-size building as to pieces, nailing, and bracing. Small wire reinforcing was then installed and a test-load applied by adding 10-pound bags of sand. A check was kept on roof sag and distortion, roof sag proving to be the criterion of the value of the system. Without reinforcing, a uniformly distributed load of 90 pounds on the 6 x 10 feet

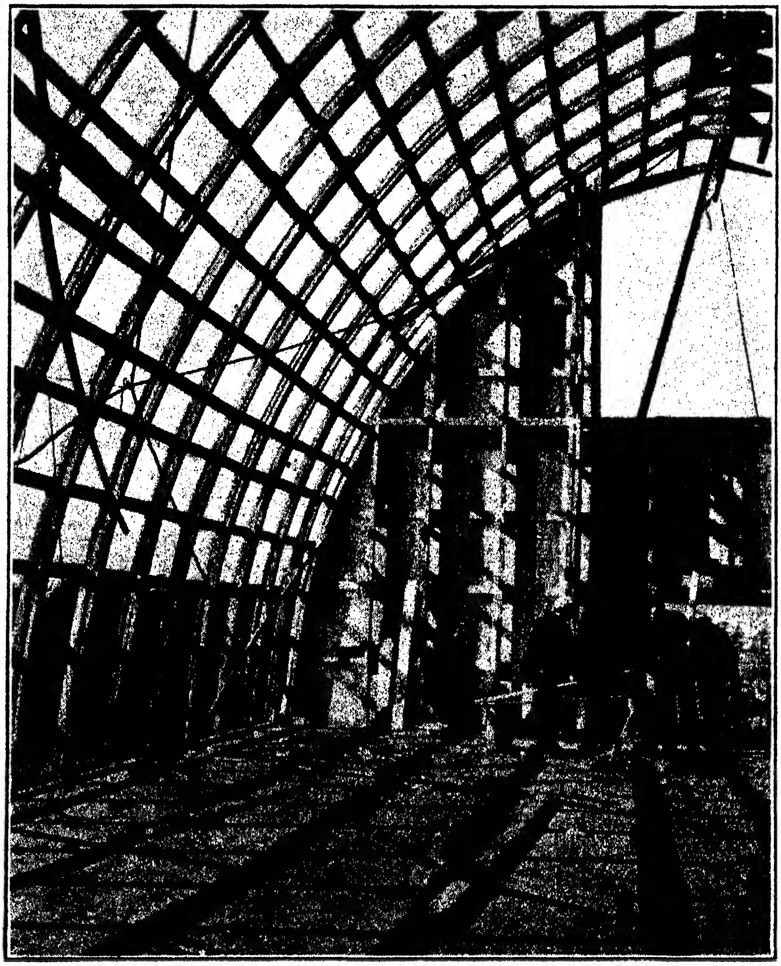

Fig. 3. Showing reinforcing cables hung loosely in place crossing at the center of the barn. They are tightened by wiring to the rafters every 4 or 6 feet, for the lower 2/3 of their length.

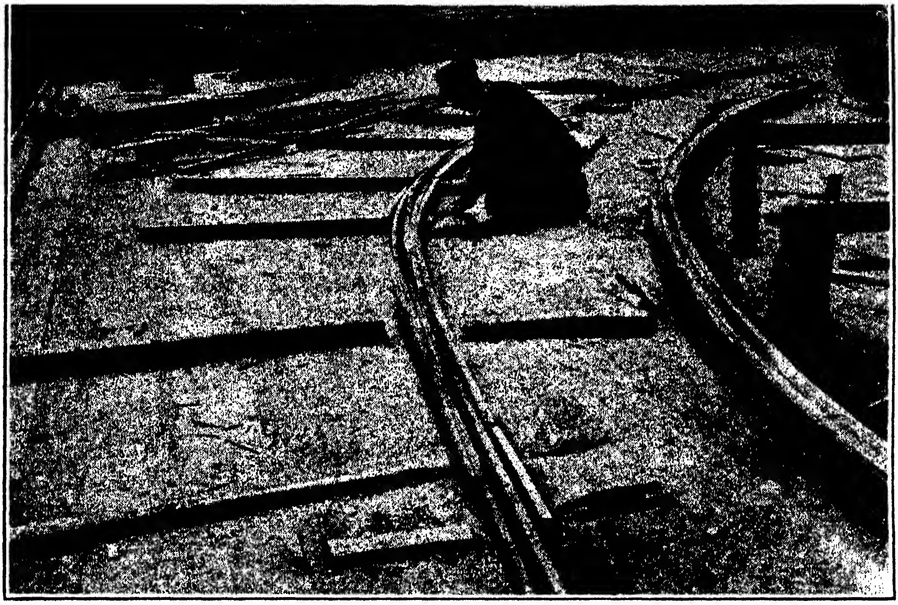

Fig. 4. Assembling units in the forms and wedging. The forms are spiked to the barn floor. The jack shown at the lower edge of the picture against the end of the inner member forces it outward compacting the entire group.

structure proved to be about the limit without undue distortion. When the cables were installed, the ridge was given ¾-inch camber or rise in the center. With a uniformly distributed load of 2,000 pounds or 200 ten-pound bags, the camber or center rise was reduced to ⅛-inch. Just what relation the load on the model bears to that on the full-sized structure is somewhat problematical, but the load applied on the small model was equal to 36.6 pounds per square foot over the floor area or projected roof area of the structure. The load concentration was approximately 60 pounds per square foot or about twice the actual allowance made in the design of full-sized buildings for combined snow and wind load.

Laying Out

Laying out the forms for the construction of the curved rafter is relatively simple, but it is necessary to provide a rigid, level surface on which to work. In barn construction the foundation and walls are first built and the floor laid. The floor provides an excellent base for the forms and the rafters are at the point needed when finished. Where a floor is not used it is necessary to provide a base of plank laid on cross pieces of "2x6's" spiked to posts driven solidly into the ground.

In laying out the curve of the rafter, chalk-lines are arranged at right angles. One of these lines forms the center line of the building and the other the base or line across the top of the plates on which the rafters are set. For round-roof construction, the intersection of these lines is a center from which the arc of the rafter is described using

one-half the width of the building as the radius. For the barn roof a radius of three-fourths the width of the building is usually used and the center for the radius line is on the base line at one-quarter the width of the building from the center line.

After the arc of the rafter is described, a row of "2x4" blocks about 2 feet apart with ends on the line is spiked to the base. These form the outside of the rafter. A similar row of blocks is set opposite to these, 6 inches from them where five laminations are to be used. Between these blocks wedges made from "2x4's" are used to force the layers together, after which they are spiked from each side about 8 inches apart with the largest spikes, usually 30-penny, which can be used without excessive splitting of the material. The ends may then be sawed with a crosscut saw on the base and center line. Some builders using smaller nails start with two or three layers, nail and add other layers with additional nailing.

Another method of rafter construction may be used. All layers are placed in the form and held snugly with wedges, A stop block is pro-

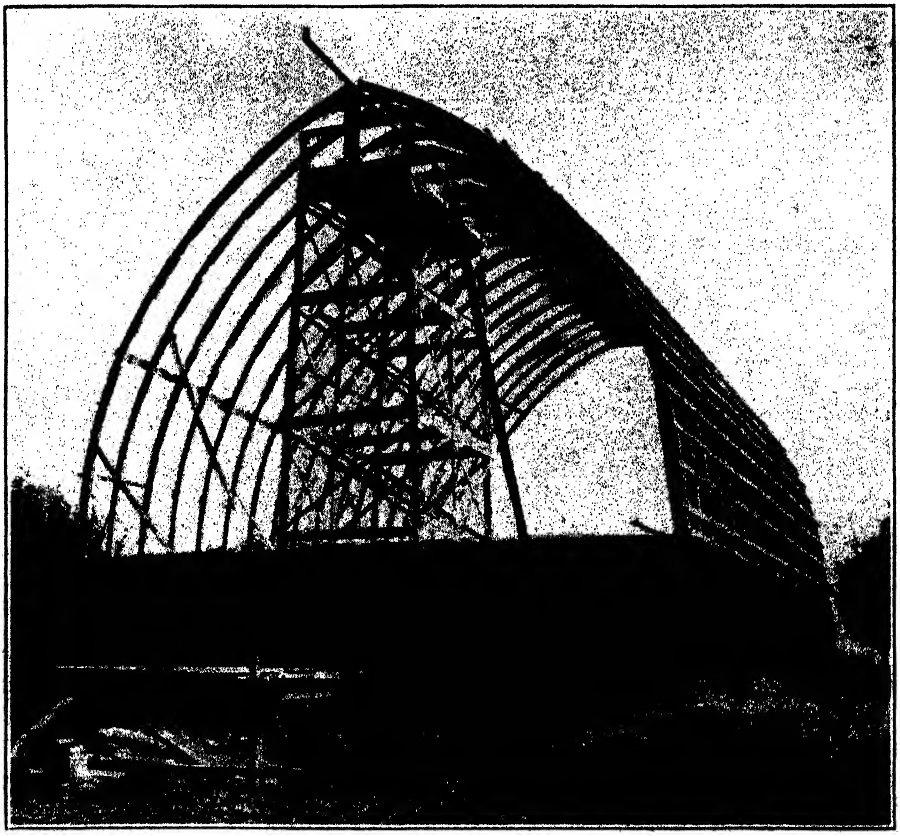

Fig. 5. Showing movable scaffold with ridge and rafters in place. Collar beams 2 x 6 inches tie the upper ends of the rafters together and provide a place for attaching hay track. End hay doors are to be used in this barn.

vided at one end of the assembly and a truck jack, set against another block as a base, is extended against the end of the inner layer forcing it outward all along the rafter and compressing the set against the outside row of blocks, after which they are fastened.

Erection

For erection a movable scaffold 8 feet by 10 feet or 10 feet by 12 feet, with a plank platform 4 feet below the ridge, has been found usable. In fact, this scaffold is the only one necessary. In erecting, the upper ends of the first pair of rafters are raised to the platform, with rope and pulley and the first section of the ridge ,consisting of a 6 foot and 12 foot length spiked together, are also taken up. The first pair of rafters is then set and stayed in place with one end of the ridge between the rafters and the opposite end supported on a post. With the ridge in place, additional rafters are set up and the scaffold moved. Since the ridge is double, starting with a half and full length of material, full length material is easily added making joints at each half length of material as the work advances.

Roofing

Roof boards of 1 inch by 6 inch or 1 inch by 8 inch, or 2 inch by 4 inch purlins, spaced approximately 18 inches apart, may be used for roof supports. Corrugated steel roofing or V-crimped roofing may be used, with preference being given to corrugated, since bending slightly stiffens the sheets. With roof boards a tighter roof may be obtained, but 2 inch by 4 inch purlins are economical and furnish a solid nailing base. Where other than steel roof is used roof boards must be spaced 2 inches or less apart.

An effort has been made in this article to cover essentials only for this type of construction. Additional use of the system will undoubtedly develop many angles of the problem.

PULLET MORTALITY

Some Observations on the Effect of Adding Wheat Germ Meal to the Laying Ration

J. A. DAVIDSON and P. J. SCHAIBLE
SECTIONS OF POULTRY HUSBANDRY AND AGRICULTURAL CHEMISTRY

Laying pullet mortality has been constantly increasing. Ferguson (1) has estimated that an increase of 70 per cent has occurred in the last 15 years. It is believed by many investigators that a greater incidence of leukosis and other neoplastic diseases is primarily responsible for the higher mortality. As yet the causative agents of this group of diseases are not known. Recent studies by Butler and

Table 1. Composition of mash used.

Oyster shell and grit in hoppers. Small amount of whole wheat fed.

Ingredient	Pen 4	Pen 9	Pen 10
Ground yellow corn	46.5	....	46.5
Ground oats	12.0	12.0	12.0
Wheat bran	17.0	17.0	17.0
Flour middlings	10.0	10.0	7.0
Ground barley	....	47.5	....
Alfalfa meal (Mich.)	3.0	3.0	3.0
Meat scrap (50 per cent)	3.0	2.0	1.0
Dried skim milk	3.0	3.0	3.0
White fish meal	1.0	1.0	1.0
Steamed bone meal	3.0	3.0	3.0
Salt	.5	.5	.5
Sardine oil	1.0	1.0	1.0
Vitamin A supplement	(*)	....	....
Wheat germ meal	....	....	5.0

*2000 A. D. M. A. units per bird per week.

Warren (4) have suggested the possibility that a lack of vitamin E may be involved.

Card *et al* (5) have shown that vitamin E is essential for poultry and that it was present in cereal grains and grasses in sufficient amounts adequately to meet the requirements of poultry. Hathaway and Davis (6) found that rations containing 20 to 25 per cent of ground alfalfa, bran, shorts, linseed oil meal, hominy feed, white corn, cotton seed meal, kafir, or yellow corn supplied adequate vitamin E for rats. Practical poultry rations would appear, therefore, to be well-fortified in this respect. Nevertheless, Pacini (2, 3) has drawn attention to the possibility that destruction of vitamin E may result from grinding of grains or the presence of rancid fats and oils in the ration (7).

In view of the interest shown at the present time on the effect of vitamin E upon mortality, it was thought advisable to report the results obtained when wheat germ meal, a potent source of vitamin E, was incorporated in the ration of pullets.

Condition of Trial

For the purpose of this report data upon three lots of 90 White Leghorn pullets are given. These lots were confined and fed the rations shown in Table 1, from Oct. 1, 1935, until Sept. 1, 1936. Management of the three lots was identical. The birds in pen 10 were fed a mash containing 5 per cent wheat germ meal which replaced part of the meat scraps and middlings of a high (pen 4) and low (pen 9) vitamin

Table 2. Average percentages of protein, calcium and phosphorus in the mash.

	Pen 4	Pen 9	Pen 10
Protein	13.75	15.00	14.39
Calcium	1.27	1.37	1.25
Phosphorus	1.09	1.17	1.09

Table 3. Feed consumption and egg production.

Feed in pounds.

	Per cent Production			Mash			Wheat			Oyster Shell			Grit		
Pen	4	9	10	4	9	10	4	9	10	4	9	10	4	9	10
October	35.22	28.29	31.47	6.24	6.50	6.48	.62	.63	.63	.17	.16	.18	......	......	......
November	44.13	31.03	38.79	6.11	6.45	6.55	.63	.63	.62	.22	.16	.19	.37	.37	.27
December	40.69	51.10	52.38	6.55	7.59	7.89	.66	.65	.64	.20	.28	.27	.43	.50	.40
January	37.64	35.86	35.66	7.78	7.55	6.65	.63	.65	.65	.17	.21	.19	.73	.61	.65
February	34.49	23.44	16.08	7.19	7.51	7.07	.61	.64	.64	.20	.13	.10	.74	.52	.54
March	58.81	50.53	44.26	7.44	7.67	7.27	.63	.65	.69	.26	.28	.39	.72	.44	.33
April	34.90	31.26	46.24	5.22	5.63	6.02	.62	.64	.68	.12	.16	.03	.38	.47	.18
May	47.29	43.53	48.77	6.14	6.10	6.12	.64	.67	.71	.20	.19	.21	.33	.53	.17
June	52.78	46.72	49.75	6.05	6.22	5.73	.62	.66	.68	.19	.19	.19	.18	.27	.13
July	46.84	41.71	32.14	5.26	7.13	4.55	.66	.68	.72	.16	.20	.11	.14	.16	.11
August	34.04	26.20	29.33	4.83	5.06	4.57	.65	.66	.71	.13	.14	.12	.09	.15	.15
Total	42.20	37.13	38.64	68.81	73.41	68.90	6.97	7.16	7.37	2.02	2.10	1.98	4.11	4.02	2.93

Table 4. Hatching results.

Date	Eggs Set			Infertile			Early Dead Germs			Late Dead Germs			Dead in Shell			Cripples and Dead on Tray			Cull Chicks			Saleable Chicks		
Pen.....	4	9	10	4	9	10	4	9	10	4	9	10	4	9	10	4	9	10	4	9	10	4	9	10
April 17..	150	136	140	14	11	27	1	5	1	2	5	3	35	55	26	1	0	0	3	8	8	94	52	75
April 22..	150	150	145	8	8	15	2	0	0	5	8	3	31	61	35	9	3	4	2	0	1	93	70	87
April 28..	150	150	150	16	8	14	3	4	4	6	10	3	47	72	55	5	1	4	7	12	12	66	41	58
May 6..	86	138	147	5	16	28	3	9	3	4	6	0	31	36	32	3	1	4	4	14	15	36	56	65
May 20..	150	130	89	4	14	5	1	8	2	12	6	1	24	30	23	4	3	2	4	8	1	101	61	55
May 29..	112	119	138	1	4	20	6	2	1	0	5	3	19	24	31	2	2	1	2	4	7	82	78	75
Total....	798	823	809	48	61	109	16	28	11	29	40	13	187	278	202	24	10	15	22	46	44	472	358	415

Hatching percentages.

Pen	4	9	10
Per cent Fertile eggs	94.0	92.5	86.5
Per cent Hatch	59.1	43.4	51.2
Per cent hatch of fertile eggs	62.9	46.9	59.2

Table 5. Mortality by months.

Month	Pen 4	Pen 9	Pen 10
October	1	1	4
November	5	2	7
December	3	5	4
January	3	5	5
February	1	4	2
March	2	2	4
April	8	3	5
May	7	7	3
June	3	3	2
July	5	1	4
August	1	4	5
Total	39	37	46
Per Cent Mortality	43.3	41.1	51.1

Per cent mortality, 460 other birds: 39.5.

A ration. The wheat germ meal was obtained in two lots, one in September and the other in December 1935, and was stored in an unheated room during the period of the trial. It was incorporated in the ration six times during the 11-month period.

All birds which died during the trial were autopsied by Drs. H. J. Stafseth or W. W. Thompson of the Bacteriology Section.

Observations on Egg Production and Hatchability

Table 3 gives the percentage of egg production on a hen-day basis as well as the feed consumption by months during the entire period. It will be observed that the addition of wheat germ meal to the ration

Table 6. Causes of mortality.

	Pen	Crop Bound	Lymphomatosis	Salpingitis	Leukosis	Neuro Lymphomatosis	Pick-outs	Unknown	Miscellaneous
Results of Autopsies	4	4	5	4	4	1	3	0	18
	9	5	3	1	7	2	7	0	12
	10	1	5	7	6	1	12	4	10
Per Cent of Total Mortality	4	10.2	12.8	10.2	10.2	2.5	7.6	0	46.1
	9	13.5	8.1	2.7	18.9	5.4	18.9	0	32.7
	10	2.1	10.8	15.2	13.0	2.1	26.0	8.6	21.7
	460 other birds	3.2	6.6	11.5	10.4	4.9	17.5	6.6	39.0

did not increase egg production. Pen 9 on the low vitamin A ration ate more feed and produced the least number of eggs.

It is known that the lack of vitamin E in the ration of hens affects hatchability by increasing the number of early and late dead germs (8). In this trial (Table 4) the pen receiving wheat germ meal produced slightly fewer early and late dead germs but slightly more infertile eggs than the other pens. The number of dead in the shell was high with all three rations and showed no improvement because of the inclusion of wheat germ meal.

Mortality

During the first few months of the trial the mortality (Table 5) was greatest in the pen receiving the wheat germ meal. A higher incidence of "pick-outs" was responsible for the increased mortality in this pen. If deaths due to this cause are not considered it is to be noted that the three lots of birds were comparable and check well with 460 other birds which were housed in the same building during the same period.

The general distribution of mortality according to causation as shown in Table 6 differed but little among the birds of the three pens and was similar to the 460 birds mentioned above. It is to be noted that the incidence of leukosis, lymphomatosis and neuro-lymphomatosis was not reduced by the inclusion of 5-per cent wheat germ meal in the laying ration.

It is calculated that each bird received from wheat germ meal during the experimental period 177 cc. of wheat germ oil. Further amounts of vitamin E were obtained from the other constituents of the ration. This quantity is in excess of the amount needed to supplement a vitamin E-free ration (5) or that which has been found necessary to prevent or cure leukosis and allied diseases (4). It is not known how much destruction of vitamin E occurred under the conditions of this experiment but it is not believed to have been extensive. It may be pointed out that the incidence of leukosis did not increase significantly as the experiment progressed.

Literature Cited

1. Ferguson, C. M., A survey of adult mortality among laying flocks of the middle west. Mimeo. report, Agr. Ext. Service, Ohio State University. 1937.
2. Pacini, A. J., New facts about vitamin E. Hatchery Tribune, December 1937.
3. Pacini, A. J., Vitamin E and fowl leukosis. Feedstuffs, December 1937, p. 11.
4. Butler, W. J. and Warren, D. M., Vitamin E and fowl leukosis. Mimeographed article from the Livestock Sanitary Board of Montana.
5. Card, L. E., Mitchell, H. H. and Hamilton, T. S., Further studies on the vitamin E requirements of poultry. Poul. Sci. Proceedings. 1930.
6. Hathaway, I. L. and Davis, H. P., The vitamin E content of certain dairy feeds. Nebr. Agr. Exp. Sta. Bul. 73. 1934.

7 Matill, H. A., The oxidative destruction of vitamin A and E and the protective action of certain vegetable oils. Jour. Am. Med. Assoc. **89:** 1505. 1927.

8. Barnum, G. L., The vitamin E content of eggs as related to the diet of the hen and to hatchability. Jour. of Nutr. **9:** 621. 1934.

FEEDING AND GROWING OF DRAFT FOALS

R. S. HUDSON AND LEONARD H. BLAKESLEE
SECTION OF ANIMAL HUSBANDRY

The results reported in this article are from two extensive feeding experiments conducted at Michigan State College, involving 48 weanling foals, fed on three different planes of nutrition to working age at three years old. The first group of 24 were Michigan draft foals, sired by purebred draft stallions and were fed experimentally from Dec. 1, 1931, to Feb. 28, 1934. Details as to how these colts were divided into three lots of eight colts each and were fed liberal, conservative, and limited rations of grain, respectively, are found in Mich. Agr. Exp. Sta. Spec. Bul. 253.

The second group of 24 were weanling foals from Dakota range mares and purebred Belgian stallions. They were fed from Oct. 13, 1933, to April 1, 1936, when they were sold, as three-year-olds, to Michigan farmers. Each lot of eight colts was fed somewhat like the lots in the previous experiment; that is, grain was fed at the rate of 2 pounds, 1 pound, and ½ pound per hundredweight daily in lots 1, 2 and 3, respectively, during the first winter of the test. The hay allowance was the same for all lots. For the purpose of studying in greater detail the effect of liberal feeding early in life upon later development, Lot 1 was divided at the beginning of the second winter, four individuals being fed similar to Lot 2 and the other four like Lot 3. These lots were then designated as Lots 1a and 1b, respectively. After being fed the first two winters on different planes of nutrition, all colts were fed a ration to put them in medium condition for sale. During the summer, all colts were pastured together.

Individual weights were taken at the start and finish of each feeding and pasture period. These weights, taken along with a set of 10 body and limb measurements, including height of withers, depth of body, heart girth, length of shoulder, length of back, depth of hock, depth of rear cannon, depth of front cannon, width at shoulder points, and chest floor to ground, were used to study growth and development. At 4½ years of age, measurements were again taken to determine development near maturity.

The experiments were conducted in such a fashion that at least four colts were developed by one of five different methods of feeding. Listed in order of decreasing cost and by lot number, the different methods were.

1. Fed liberally to work age, Lot 1 Michigan colts.
2. Fed liberally first winter and conservatively thereafter, Lot 1a Dakota colts.
3. Fed liberally first winter and a limited ration thereafter, Lot 1b Dakota colts.
4. Fed conservatively to work age, Lot 2 Michigan and Dakota colts.
5. Fed a limited ration to work age, Lot 3 Michigan and Dakota colts.

Liberal feeding is considered a grain allowance at the rate of 2 pounds daily per 100 pounds of weight; a conservative grain ration, 1 pound daily per 100 pounds of body weight, and a limited ration ½ pound of grain daily per 100 pounds of weight. Hay was fed at the rate of approximately 1 pound daily per 100 pounds of weight. In addition, all colts were given oat straw to provide sufficient roughage.

Average daily gains per colt for the entire feeding period varied from 1.15 pounds in Lot 1 Michigan colts to 0.83 pound in Lot 3 Michigan colts. However, over different periods, gains varied from 2.4 pounds daily in Lot 1 to 0.57 pound daily in Lot 3. All colts made a steady increase in body measurements and in weight through the entire feeding period, and though the increase was low in the limited fed lots there were no signs of stunted growth or of rickets as might be expected. Further evidence that Lot 3 colts were not stunted is that all Lot 3 Michigan colts increased in height at withers and in depth of body after going to work, while Lots 1 and 2 either maintained their three-year-old measurements or decreased slightly, owing to loss of flesh. This increase in Lot 3 was such that the average measurements on all three lots were practically the same at 4½ years of age. All of the Dakota foals continued to develop in height at withers and in depth of body during their fourth and fifth years.

Lot 1b Dakota colts, fed a liberal ration the first winter and a limited ration the second winter, gained 127 pounds per head the second winter in comparison with Lot 3 colts which gained only 97 pounds on a

Table 1. Average weights and gains per colt by periods, Dakota foals.

	Lot 1a		Lot 1b		Lot 2		Lot 3	
	Average Weight (Pounds)	Average Gain (Pounds)	Average Weight (Pounds)	Average Gain (Pounds)	Average Weight (Pounds)	Average Gain (Pounds)	Average Weight (Pounds)	Average Gain (Pounds)
Initial Weight Oct. 13, 1933	483	....	488	....	466	....	468	....
End of First Period May 12, 1934	851	368	843	355	814	348	730	262
End of Second Period Nov. 15, 1934	1,064	213	1,092	249	1,024	210	965	235
End of Third Period May 3, 1935	1,247	183	1,219	127	1,227	203	1,062	97
End of Fourth Period Nov. 15, 1935	1,431	184	1,434	215	1,386	159	1,287	225
Total Experimental Gain	....	948	....	946	....	920	....	819
Final Weight Mar. 31, 1936	1,441	10	1,461	27	1,436	50	1,315	28
TOTAL GAIN	....	958	....	973	....	970	....	847

limited ration, as shown in the table. This indicates the desirability of feeding weanling foals liberally to obtain greater weight and development. These Lot 1b colts, at approximately the same cost, made a greater total gain than did Lot 2 colts, fed a conservative ration both winters.

In view of these results, it seems advisable to supply not less than one-half pound of grain daily per 100 pounds of weight to keep young colts in a thrifty condition and growing. Colts fed this amount cost less to produce, but during the winter will be in poor flesh and, therefore, not in sale condition. The best results, from the standpoint of gain, condition, cost and advantage in marketing were obtained first, by feeding liberally the first winter and conservatively thereafter, second, by feeding conservatively to working age. From the standpoint of gains and cost, the colts fed a liberal ration the first winter and a limited ration the second winter showed no advantage over the other two methods.

Summary

1. Maximum development and draftiness are insured by feeding weanling foals a mixture of equal parts of oats and ear corn by weight, at the rate of 2 pounds per hundredweight daily, along with 1 pound of clover or alfalfa hay per hundredweight daily, for the first winter. Each winter thereafter, not less than ½ pound daily of grain per hundredweight should be fed, and 1 pound is recommended.

2. Conservative feeding, at the rate of 1 pound of grain and 1 pound of hay daily per hundredweight, with access to oat straw, is a safe, economical method of developing weanling foals to working age.

Example: For an 800-pound foal, feed 8 pounds daily of a mixture of oats and ear corn, equal parts by weight, along with 8 to 10 pounds of clover or alfalfa hay, supplemented by free access to oat straw.

3. Colts fed a limited ration of grain to working age lacked condition and weight. Since weight and good condition are essential in draft animals, these colts were the least desirable for sale at any time during the experiment.

4. All colts were wormed each winter to keep them free from internal parasites and in thrifty condition. This was found very necessary in Lot 3.

GRINDING HAY AND GRAIN FOR FATTENING LAMBS

G. A. BROWN AND L. H. BLAKESLEE
SECTION OF ANIMAL HUSBANDRY

The subject of feed preparation by means of grinding or chopping has received much consideration by Michigan farmers recently. The desire to utilize self-feeders for lambs has resulted in the grinding of a great deal of roughage to be mixed with the grain for the sake of providing a rather bulky mixture in the self-feeders or one on which the lambs would not find it possible to over-eat on grain.

Table 1.

	Lot 1	Lot 2	Lot 9	Lot 7
	Hand-fed Shelled Corn Long Alfalfa Hay	**Self-fed** First 10 days 2/3 Ground Alfalfa 1/3 Cracked Corn Second 10 days 1/2 Ground Alfalfa 1/2 Cracked Corn Thereafter 1/3 Ground Alfalfa 2/3 Cracked Corn	**Self-fed** First 10 days 2/3 Cut Alfalfa 1/3 Cracked Corn Second 10 days 1/2 Cut Alfalfa 1/2 Cracked Corn Thereafter 1/3 Cut Alfalfa 2/3 Cracked Corn	**Self-fed** 4 parts Cracked Corn and 1 part Ground Alfalfa with Long Hay in Rack
Number of trials	5	5	3	5
Number of lambs fed	117	114	77	114
Length of feeding period (days)	83	83	83	83
Average gain per lamb (lbs.)	30.47	30.25	27.68	32.25
Average daily gain per lamb (lbs.)	0.36	0.36	0.33	0.38
Feed consumed per 100 lbs. gain:				
Shelled corn (lbs.)	367	....	....	....
Long Alfalfa Hay (lbs.)	437	....	....	267
Cracked corn	....	415	438	398
Ground Alfalfa Hay (lbs.)	....	288	....	99
Cut Alfalfa Hay (lbs.)	....	....	317	....
Feed cost per 100 lbs. gain	$6.78	$7.37	$7.63	$7.25

The authors wish to raise the question as to whether the grinding of roughage is desirable from the standpoint of cost. Grinding adds materially to the cost of the preparation of feed and it is extremely doubtful if any labor is saved by self-feeding when it is necessary to grind large amounts of roughage and mix it with the grain.

The accompanying table gives a brief summary of the results of five trials conducted at Michigan State College, using the rations as given.

The foregoing trials were conducted to determine satisfactory methods of self-feeding lambs, to compare hand-feeding and self-feeding, and to throw some light upon the cost or value of grinding roughages. It will be noted that all lots were fed the same length of time, namely 83 days. There was very little difference in the total gain per lamb. The lambs on cut hay in Lot 9 gained somewhat less than those in any of the other lots. It was apparent that these lambs did not eat the cut hay with the same relish as the lambs in lots 2 and 7 ate the ground hay. It was thought that the sharp ends of the cut sections bothered the lambs somewhat, thus resulting in slightly slower gains. Lot 7, which received only 20 per cent of ground hay with 80 per cent of cracked corn, gained somewhat more rapidly than the other lots. Any of the above gains, however, would be considered satisfactory for fattening lambs.

There was considerable difference in the amounts of hay consumed by the different lots. Lot 1, hand-fed shelled corn and long alfalfa hay, consumed an average daily ration of 1.6 pounds of hay and 1.34 pounds of shelled corn. Lot 2, fed as indicated above, consumed an average daily ration of 1.52 pounds of cracked corn and 1.05 pounds of ground hay. Lot 9, self-fed cracked corn and cut hay, consumed an average daily ration of 1.46 pounds of cracked corn and 1.06 pounds of cut alfalfa hay. Lot 7, self-fed a mixture of 4 parts cracked corn

and 1 part ground alfalfa hay with long hay fed in a rack, consumed an average daily ration of 1.54 pounds of cracked corn, 0.39 pound of ground hay, and 1.04 pounds of long hay. It will be noted from the foregoing that the self-feeding of cracked corn and ground hay in the proportions fed resulted in an increased grain consumption and a decreased hay consumption per 100 pounds of gain produced.

Charging the various feeds at the prices indicated above, the feed cost of gain in Lot 1 was $6.78 per hundredweight. In Lot 2, the feed cost per 100 pounds of gain was $7.37, an increased cost, as compared with Lot No. 1, of 59 cents per 100 pounds of gain produced. The cost of grinding in this lot was 74 cents. Had the cost of grinding the 700 pounds of feed, consumed for each 100 pounds of gain, been 2 cents per hundredweight, then the cost of gains in Lots 1 and 2 would have been identical. In Lot 9, fed cut hay and cracked corn, the feed cost for 100 pounds of gain was $7.63. The cost of cutting the hay and cracking the corn was 57 cents. In order to make the feed cost of gain the same as in Lot 1, someone would have to pay the feeder 3.6 cents per hundredweight for cutting the hay and cracking the corn. In Lot 7, where some long hay was fed and only 20 per cent of ground hay added to the cracked corn, the feed cost per 100 pounds of gain was $7.25 per hundredweight. Had no charge been made for grinding the hay or cracking the corn, the feed cost per hundredweight gain in this lot would have been the same as it was in Lot 1.

Though grinding or chopping hay does facilitate handling and reduce storage space required, it is an extremely doubtful practice from the standpoint of economy of gains and cost of feeding. It will be noted in the preceding trials that feeding the ground mixture resulted in increased grain consumption and decreased hay consumption. It is true that less hay was wasted with the ground rations. Hay is frequently of poor quality, and grinding in order to force the lamb, or any other fattening animal, to consume the coarse, fibrous material, which would be wasted in the case of long hay, is poor economy. In other trials under way at the Michigan Agricultural Experiment Station, in which ground hay has been fed as the larger part of the ration, with grain held to a limited amount, the cost of producing gains has still been higher than has been the case with hand-feeding shelled corn and long hay.

THE ZINC CHLORIDE TREATMENT FOR FIRE-BLIGHT

DONALD CATION
SECTION OF BOTANY

The drenching method of treating cankers consists of the application of a penetrating chemical to the uncut surface of the bark. An ideal solution for this purpose should penetrate the bark and kill the bacteria, without killing the plant tissues. As plant cells and bacteria react similarly to toxic chemicals, such an ideal solution has not been

found, but owing to certain characteristics of the host relationship to the bacteria, it is possible to use such solutions to advantage in combatting the disease. Of the solutions which have been used in the treatment of blight cankers by the drenching method, the zinc chloride-alcohol solutions show the most promise.

The zinc chloride treatment was devised by Leonard H. Day of the California Agricultural Experiment Station. He published bulletins explaining this treatment in 1928 and 1930. McClintock of Tennessee later tried this method on apple trees and reported good results. In tests conducted by Parker in New York, blight cankers were stopped 100 per cent in apple using the strong and medium solutions in 1930; 86 per cent to 100 per cent on pear using the weak solution in 1931; and 92 per cent on pear using the weak solution in 1933. Zinc chloride solutions were used with success by a group of students as a class project in the college pear orchard at East Lansing in 1936. Several Michigan growers who have tried this new method of treating blight report favorable results.

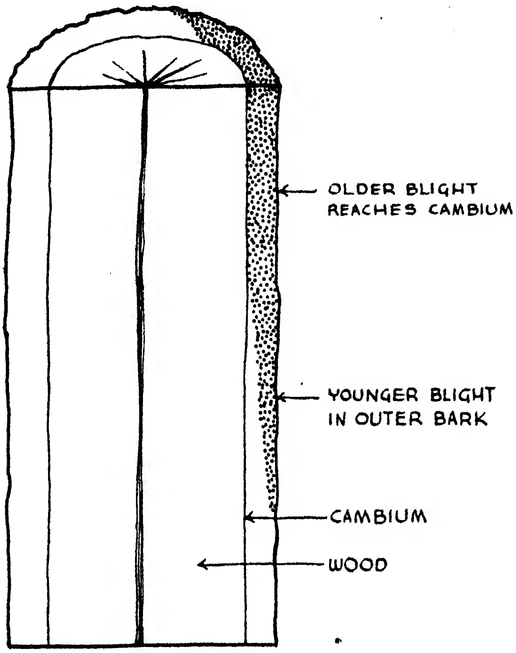

Fig. 1. Apple and pear blight. Location of bacteria in the branches.

This article briefly describes the zinc chloride drenching method of treating fire-blight cankers. It also reports the successful use of this material in a single experiment conducted under Michigan conditions. It is realized that the zinc chloride treatment has not had sufficient testing to deserve unqualified recommendation. It has, however, shown enough promise to warrant a limited trial by Michigan fruit growers.

In a fresh blight infection the bacteria work at first in the cortex or outer bark as they travel up or down a limb. As the infection becomes older they gradually work deeper into the tissues, reaching the cambium in about two weeks. This is illustrated in Fig. 1. On the outside of the limb there is a layer of corky bark which cannot be penetrated by the ordinary water solutions. It is evident that a solution strong enough to penetrate the bark but not strong enough to reach the cambium could kill the bacteria without killing the limb. With the correct strength of zinc chloride used under the right conditions, this is exactly what happens. For this reason zinc chloride is considered especially useful in treating early cases of fire-blight.

The zinc chloride solutions have selective permeability. They will

sink deeper into blighted tissue than into healthy tissues. The material is not very expensive, is easy to apply, and with due precautions is fairly safe to handle from the standpoint of the operator. The zinc chloride treatment is not without the limitations, but it does give us one more weapon for fighting fire-blight.

A successful experiment was conducted with this material in 1933 in the Wm. Teichman orchard at Eau Claire, Mich. In this seven-year-old pear orchard of approximately 175 trees there were 47 trees showing considerable fire-blight. The blight had been cut back early in the season by the usual methods of summer cutting, with repeated tool disinfection. No re-check had been made and the usual escapes were responsible for the blighted condition of the 45 trees in mid-August. In many cases the blight had run down into the leaders, and even into the main trunks. Treatments were made at that time using 43-per cent zinc chloride on most of the cankers. Hopelessly blighted limbs were cut out but certain cankers were treated by painting them with zinc chloride solution. One typically blighted tree was left untreated as a check.

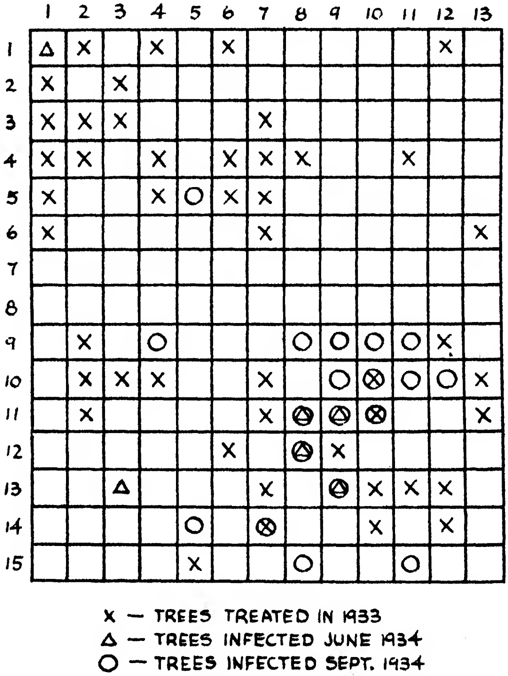

Fig. 2. Zinc chloride treatments and control at Teichman orchard, 1933-'34.

Examinations were made the following year in June and September. In June it was apparent that none of the treated cankers lived over. There was no new blight on any of the treated trees. The canker on the check tree (Row 1 Tree 1) showed spread and activity in June and there were several new infections on that tree. Six trees in this orchard showed new blight but none of these had received the zinc chloride treatment the year previous. It seems probable that the new blight was the result of a carry-over from undetected cankers of the previous year.

On September 1 examination disclosed 16 trees showing one or more blighted branches, but as only three of these trees had received the zinc chloride treatment the year before and as these trees were adjacent to the trees already infected on June 1, it seems apparent that the infections came from the untreated trees. In every case the zinc chloride treatment seemed effective in stopping the blight. As

the blight had advanced too far before the treatments were applied, no limbs were saved that could not have been saved by the surgery treatment. The zinc chloride treatment was, however, easier, and saved much time and arduous labor as compared with the ordinary surgical treatment. Earlier zinc chloride treatments, applied before the blight had traveled so far and so deep, could no doubt have saved many limbs and future fruiting wood. A diagram of the orchard showing treated and blighted trees is shown in Fig. 2.

The zinc-chloride treatment would be most useful in the early treatment of the numerous small cankers which accompany an outbreak of fire-blight. The method is not without its difficulties. The operator will have to learn what strengths of solution to apply to different sized branches during the different seasons of the year. It is also difficult to tell whether a treatment is fully effective as even healthy bark treated with these strong solutions becomes spongy and sappy. For the sake of future examinations it is best to mark the limits of the treated area with tacks. It will then be easy to see later whether the blighted area has spread.

For rapidly advancing cankers, a distance of 10 to 12 inches above and below the last visible limits of blight is not too much of an area to treat. For dormant cankers a distance of 2 or 3 inches up and down past the canker limits is sufficient. If it rains within three days after treatment it will be necessary to repeat the job. The zinc chloride, being water-soluble, would wash away.

The zinc chloride solutions are painted on the cankers with a one-inch cheap paint brush. The solutions penetrate variably according to the age of the tree, the thickness of the bark, the condition of the tree, the season of the year and the temperature. Stronger concentrations penetrate more deeply than weaker concentrations. The strength of solution to apply must be judged by the operator according to the conditions in his own orchard, from trials and observations.

The following strengths are suggested for trial in Michigan:

Pear Trees

Older than 20 years—

Use 53 per cent on trunks and branches
Use 43 per cent on roots over 2½ inches diameter
Use 33 per cent on roots under 2½ inches diameter.

On trees from 6 to 20 years of age—

In cool weather use 53 percent on everything over 2½ inches diameter
In cool weather use 43 per cent on roots over 2½ inches diameter
In cool weather use 33 per cent on roots under 2½ inches diameter
In warmer weather use 43 per cent on trunks and branches.

Trees from 2 to 5 years of age—

Use 43 per cent and 33 per cent, mostly 33 per cent.

For apple trees use the stronger solutions.

Directions for making zinc chloride solutions:—

Ingredients: Powdered zinc chloride (commercial grade)
Denatured alcohol (a good grade of radiator alcohol)
Hydrochloric acid (commercial grade)

To make zinc chloride solution 53 per cent:—

To two pints of hot water add three ounces of hydrochloric acid. Then add 9 pounds of zinc chloride and dissolve. Bring to a boil if necessary. When dissolved, pour this solution into 7 pints of denatured alcohol.

To make zinc chloride solution 43 per cent:—To 1 gallon of 53 per cent solution add 3 pints of alcohol.

To make zinc chloride solution 33 per cent:—To 1 gallon of 53 per cent solution add 1 gallon of alcohol.

To make the foregoing solutions use an enameled kettle. The solutions must be kept in glass containers only.

Caution—Zinc chloride is very caustic to wool and leather. It is not so caustic to cotton or rubber. It is usually not very injurious to the hands unless handled for a long time. Operators should carry a wet towel to keep it wiped off the hands and skin. The zinc chloride alcohol mixture is caustic and poisonous and should be kept out of reach of children and farm animals. In case of accidental ingestion, use white of egg beaten up in water, or olive oil, or a large amount of water or milk; induce vomiting; and send for a doctor. If it splashed in the eyes wash out immediately with water and follow with olive oil.

BULLETIN REVIEWS

Circular Bulletin 163—Annual Cover Crops for Michigan Orchards. Partridge, N. L. and Toenjes, W.—A discussion of the function of cover crops, the relative values of different kinds for Michigan conditions and information on seeding data and the use of fertilizers. (12 pages, 5 figs.)

Circular Bulletin 165. Celery Production in Michigan. Sections of Horticulture, Soils, Entomology and Plant Pathology—A description and explanation of recommended methods for the commercial production of celery, particularly on muck soils. (43 pages, 5 tables, 9 figs.)

Special Bulletin 288. Marketing Potatoes in Michigan with Special Attention to Market Preferences. Motts, G. N.—Michigan ranks fourth among the surplus late crop states and during the last 15 years has produced an average of 25,610,000 bushels annually. From the 1924 to 1935 seasons an average of 55 per cent of the Michigan crop has been sold by the growers, 20 per cent used in the homes, 15 per cent kept for seed, and the remaining 10 per cent fed to livestock or wasted.

In 1937 the State legislature adopted the U. S. Fancy grade, U. S. No. 1 a and b grades, U. S. commercial grade and U. S. No. 2 a and b grades as the standard Michigan potato grades. Graders and loaders have been licensed since 1929. Michigan potatoes are generally packed in 100-pound bags.

More than 90 per cent of the Michigan crop is marketed within 500 miles of the southern Michigan boundary line. About one-fifth of the

Michigan crop is shipped into other states, while one-fourth of the total potato receipts from other states arrives from other late-crop states, chiefly Maine and Idaho. A comparison of a series of samples of potatoes from Michigan, Maine, and Idaho indicated that for these samples the Michigan potatoes were equal to those from Maine in cooking qualities, but the potatoes from both states were somewhat inferior to those from Idaho in these respects.

The primary objective in improving the competitive status of Michigan potatoes must be to improve their general quality and condition. Although the fundamental problem is one of production, several adjustments in marketing are likewise indicated. These involve a more general practice of purchasing potatoes according to grade, improved handling and storage conditions, more accurate grading, more widespread use of pooling sales and a further consideration of the possibilities of consumer packages for part of the tonnage of the best grades. (68 pages, 20 tables, 12 figs.)

Technical Bulletin 156. Chemical Constitution and Biological Properties of the Endo-Antigen of the Brucella Group of Micro-Organisms. Pennell, R. B. and Huddleson, I. F.—A method is described for the preparation from cells of *Br. abortus, Br. melitensis* and *Br. suis* of a highly antigenic fraction of the endo-antigen, which is toxic for normal guinea pigs and which precipitates immune serum in dilutions of from 1-500,000 to 1-5,000,000.

Endo-antigens obtained from the three species of *Brucella* are grossly similar. The endo-antigen comprises roughly 25 per cent of the bacterial cell. Though containing the same or similar constituents, the endo-antigens from the three organisms have been shown to differ markedly in the distribution of some of these constituents.

Positive reactions are given to the Molisch test, the biuret test, Millon's test, Bial's test and a very slight reaction to the Rosenheim test. The nitrogen content of the fraction varies from 6 to 8 per cent. Reducing sugars are absent before hydrolysis. Calculated as glucose after hydrolysis, reducing sugars represent from 4 to 12 per cent of the endo-antigen. Amino-nitrogen phosphorus and sulphur are absent. In the determination of acetyl groups, distillable acid representing an average of 6 per cent of the endo-antigen is obtained. This acid is presumably acetic, although that product has not been isolated.

From the endo-antigen there may be extracted by acetone and ether a compound having the properties of diketone and an acetone-soluble saturated liquid fatty acid. These two compounds represent from 10 to 15 per cent of the fraction.

The acetone-ether extracted product still reacts positively to the above mentioned qualitative tests. Tryptophane and tyrosine have been found to represent 18.92 per cent and 8.45 per cent, 11.46 per cent and 0 per cent, 7 per cent and 9.29 per cent of the extracted endo-antigens of *Br. melitensis, Br. abortus* and *Br. suis,* respectively.

From the remaining 65 to 70 per cent of the original fraction there has been obtained an unidentified nitrogenous fraction and an optically inactive sugar acid. These are obtained in quantities such as to preclude the occurrence of any further compounds in a significant amount.

The endo-antigen is shown to be relatively stable in the presence of dilute acid and dilute alkali upon heating and upon long standing. Its

activity is not completely destroyed by hydrolysis with dilute acids but is destroyed by similar treatment with dilute alkali. The ability to precipitate specific serum is lessened by extraction with acetone and ether, but is enhanced by acetylation or by treatment with 25-per cent NH_4OH. The toxicity and anti-genicity of the endo-antigen are shown to depend upon proper dosage, an over-dosage as well as an under-dosage giving poor results. The toxicity and antigenicity are increased by lipide extraction of the endo-antigen. Acetylation causes a distinct decline in toxicity but a marked increase in antigenicity.

The endo-antigen elicits specific skin reactions in sensitized animals, the lipide-extracted and the acetylated endo-antigens showing some species specificity in this reaction. Injections of endo-antigen have failed to protect normal guinea pigs from subsequent exposure to virulent *Brucella* organisms and have failed to alter the course of the disease in infected pigs. Experiments with cattle and humans, however, seem to promise immunizing and therapeutic value to the endo-antigen.

Injection of the endo-antigen causes a hyperglycemia followed by a hypoglycemia in experimental animals. The basal metabolism of injected animals is at first stimulated and then depressed. A leukopenia, chiefly due to the disappearance of neutrophiles from the peripheral blood, follows injection of the endo-antigen into normal guinea pigs.

The endo-antigen may be produced from the previously described albuminoid fraction of the *Brucella*, thus accounting for the toxicity of that fraction and suggesting that this albuminoid is a combination of the endo-antigen with a protein-like group. The endo-antigen is shown to be similar to or possibly identical with the previously described S-substance, the latter being probably a partially hydrolyzed endo-antigen. (31 pages, 15 tables.)

JOURNAL ARTICLE ABSTRACTS

Characteristics of Persons Listed in RUS.—Thaden, J. F.—Rural Sociology 2 **(4):** 429-443. 1937. (Journal Article No. 90 (n. s.) from the Michigan Agricultural Experiment Station.)—The biographical register of rural leaders, known as RUS, contains 6,881 registrants of whom 10 per cent are farmers, 37 per cent teachers and investigators at land-grant colleges, 15 per cent specialists and officials in departments of agriculture in the various states and in the Federal government, 14 per cent vocational agriculture teachers in high schools, and 14 per cent in agricultural extension work. Contrary to a common opinion and interpretation of some studies, this study indicates that 83 per cent of the men and 60 per cent of the women (totaling 359) were reared on the farm, or both on the farm and in the town or city. Only 5 per cent of the men and 15 per cent of the women were reared wholly in the city. The states that have been most proficient in the production of agricultural experts and specialists form a belt across the central and north-central part of the United States extending as far west as

Nevada, with practically all "low" states lying to the south of this belt and most of the "medium" states lying to the north or west. Michigan ranks among the 16 "high" states. The professional agriculturists are less bound by propinquity in migrating than the general population, yet both groups of native-born migrants from Michigan tend to migrate to the same states in similar proportions. RUS registrants are slightly more than two and one-half times as migratory as laymen in regard to inter-state migration. Michigan, with 13.5 RUS registrants per 100,000 rural population, ranks 26th in this respect. The ratio varies from 3.5 in Mississippi to 53.8 in Rhode Island.

A Sensitive Hydrometer for Determining Small Amounts of Clay or Colloids in Soils. Bouyoucos, G. J.—Soil Science. **44:** 245-247. 1937. (Journal Article 295 (n. s.) from the Michigan Agricultural Experiment Station.)—A very sensitive hydrometer devised for measuring small amounts of clay or colloids in soil is described.

Stickers Used With Calcium and Zinc Arsenate. Sherman, F.—Jour. Econ. Entom. 30 **(3):** 398. 1937. (Journal Article 280 (n. s.) from the Michigan Agricultural Experiment Station.)—This report deals with tests of calcium and zinc arsenates in combination with several stickers as codling moth sprays. Under conditions of these tests, zinc and calcium arsenates combined with proper correctives and certain stickers closely approximated control obtained in comparable plots sprayed with lead arsenate.

Factors Influencing the Ripening Season of Sour Cherries. Gardner, V. R.—Jour. Agri. Res. 55 **(7):** 521-532. 1937. (Journal Article 289 (n. s.) from the Michigan Agricultural Experiment Station.)—Season of ripening of sour cherries was found to be influenced greatly by temperature and relative size of crop. Comparatively low growing season temperatures retarded and high temperatures accelerated ripening. Relatively heavy crops, especially when accompanied by a limited leaf area, tended to ripen late and unevenly; light crops tended to ripen early and evenly. Pruning of a type which removes weak wood from the lower and interior portions of the tree and other cultural practices which aid in the development and maintenance of abundant foliage promote evenness and earliness of maturity. Contrary to general opinion, heavy fertilization with nitrogen-carrying fertilizers was found to contribute to earliness and evenness of maturity. There are many bud sports in the cherry that mature earlier or later than the main crop, but they are of relatively minor importance.

A Comparison of Standard Plate Counts and Methylene Blue Reduction Tests Made on Raw Milk with Special Reference to Geometric Means. Devereux, E. D.—Jour. Dairy Sc. 20 **(11):** 719-721. 1937. (Journal Article 290 (n. s.) from the Michigan Agricultural Experiment Station.)—Data were collected on approximately 1,100 samples of raw milk to determine the geometric mean of the plate counts for each of the four methylene blue reduction test classes of milk. The means for the four classes, 1, 2, 3, 4, were found to be respectively 11,500; 153,900; 905,200; and 2,796,400. Practically two-thirds of the counts in each class were within one standard deviation of the mean of the logarithms and more than 99 per cent were within three standard devi-

ations of the mean of the logarithms. The geometric means for the four classes were found to be significantly different when a test for significance was applied. No attempt was made to fix the limits (counts) of the four different classes.

A Formula for Reducing the Computations Necessary to Find the Variance of a Set of Averages. Baten, W. D.—Jour. Agr. Res. 55 **(8):** 575-580. 1937.—(Journal Article 294 (n. s.) from the Michigan Agricultural Experiment Station.)—The yield of a three-row plot is often considered to be the average of the yields of the rows. The averages of these yields are used to obtain the mean and variance of the yields of the entire number of plots used in the experiment. The weight of a steer is often considered to be the average of three measurements of his weight taken at different times during the day. Some research workers find the average of these measurements, the deviations of these averages from the general average and then the variance of the measurements from the sum of squares of these deviations. This method calls for calculations involving many decimal fractions.

The object of this article is to show how to obtain the mean and variance of the measurements without the labor involved in finding the averages of the (two or more) measurements made at the outset and the deviations of these averages from the general mean. Applications are made to yields of three-row plots of wheat, weights of steers and intraclass correlation.

The High Degree of Accuracy of the Improved Soil Hydrometer Used in the Mechanical Analysis of Soils. Bouyoucos, G. J.—Soil Science. **44:** 315-317. 1937. (Journal Article 296 (n. s.) from the Michigan Agricultural Experiment Station.)—The soil hydrometer when placed in a soil suspension that has been allowed to settle in order to produce differences in density with depth indicates the same quantity of soil present as that in the same suspension when it is siphoned off and mixed to produce conditions of uniform density. Furthermore, the amount indicated is the same, within limits of experimental error, as that found by gravimetric determination. These facts establish conclusively that the hydrometer method is practical and accurate.

The Relation of Certain Physical Factors to Infection with Streptococcic Mastitis. Bryan, C. S. and Taylor, G. E.—North American Veterinarian. 19 **(1):** 26-30. 1938. (Journal Article 300 (n. s.) from the Michigan Agricultural Experiment Station.) — Mastitis streptococci appear to gain entrance to the udder through the teat canal or through injuries to the udder and teats. According to present knowledge the streptococci do not invade the udder by way of the blood stream. Spread of streptococcic mastitis, therefore, depends on external factors that are responsible for carrying the germs from cow to cow and aid them in gaining entrance to the udder, and to the virulence of the germs. In cases of streptococcic infection of the reproductive organs the genital excretions contain streptococci; this has been responsible for the notion that streptococcic mastitis is more prevalent in the rear than front quarters of the udder. The location of the udder with respect to its proximity to filth and the exposure of the rear quarters to excretions from the genitalia are the basis for this notion. If this

assumption is correct the rear quarters should be the first to become infected when a large number of animals are studied. In a study of 121 cows no difference was noted with respect to the initial location of the streptococci in the rear or front quarters. Dairy cows show no degree of regularity in so far as their lying down habits are concerned.

The tests employed, in decreasing order of efficiency in detecting early cases of streptococcic mastitis, are: (1) Microscopic test, (2) Physical examination of the udder, (3) Leucocyte content of the milk, (4) Chloride content of the milk, (5) Thybromol test, and (6) Physical examination of the milk.

Fifty-one of 67 (or 76.1 per cent) of the cows became infected during the first three months of their lactation period.

Evaporating the Water With Burning Alcohol as a Rapid Means of Determining Moisture Content of Soils. Bouyoucos, G. J.—Soil Science. **44:** 377-383. 1937. (Journal Article 306 (n. s.) from the Michigan Agricultural Experiment Station.)—Partial extraction with alcohol, followed by drying with burning alcohol, is presented as a rapid and accurate method of determining the moisture content in soils. The procedure consists of treating the soil with alcohol in a special apparatus and burning the alcohol, the heat from which evaporates the water and dries the soil completely. Temperature of the soil is raised to only about 130°-160° C. This has no influence on the combined water and no effect on organic matter up to about 11 per cent in mineral soils. In mucks, peats and in mineral soils containing more than about 11 per cent organic matter, especially in the undecomposed state, the method is not applicable. In mineral soils containing less than about 11 per cent organic matter the method is as accurate in determining moisture content as is the standard oven-drying method.

The method is rapid. It determines the moisture content of sands in 5 to 10 minutes, loams in 10 to 20 minutes, and clays in 10 to 35 minutes, depending on their content of water and their permeability to alcohol.

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BASICOP AS A CHERRY SPRAY[1]

DONALD CATION AND C. W. ROBERTSON
SECTION OF BOTANY

Experimental work to find a cherry spray superior to lime-sulphur and to bordeaux, both of which have disadvantages, has been under way for some time at Michigan State College. Lime-sulphur does not always give adequate control and bordeaux has been responsible for serious dwarfing of the fruit, stunting of the tree, and injury to the leaves (5) (6). Certain copper compounds have been shown by Cation and Rasmussen to give better control of cherry leaf-spot than does liquid lime-sulphur (1) and less injury to the tree and fruit than does bordeaux (6).

In addition to the other experiments a special study has included the physiological and pathological effects of basic copper sulphate sprays upon the foliage, fruit and other parts of cherry and apple trees; also the effects of this material upon the pathogene causing cherry leaf-spot *(Coccomyces hiemalis)*. This article reports results of the first year's experiments testing Basicop[2] as a cherry spray. The experiments were conducted in commercial orchards located near Hart, Shelby, Empire and Omena, Michigan. Each experiment will be discussed separately.

Roach Orchard at Hart

The main portion of the experiments at the Roach Orchard near Hart was located in a solid block of 192 trees, most of which were 15 years old. The rows, 32 trees long and 6 trees wide were divided into 16 plats of 12 trees each, each plat being 3 trees wide and 4 trees long. The treatments used for evaluating Basicop consisted of basic copper sulphate applied at varying strengths, with and without hydrated lime, on five plats: the comparative treatments of various other copper and sulphur-containing materials were applied on the remaining 11 plats. Materials and concentrations used are given in Table 1.

The spray schedule used for the 16 plats in this block was similar to that generally adopted by Michigan cherry growers and consisted of three pre-harvest and one after-harvest sprays. The treatments were applied as follows: petal-fall, May 30-31; two-week application, June 15-16; four-week application, June 26-27; and after-harvest applica-

[1]This study was made possible by funds provided by the Sherwin-Williams Co., Cleveland, Ohio.

[2]Basicop is a powdered form of basic copper sulphate, the formula of which may be considered as $CuSO_4.2Cu(OH)_2$. The pure commercial product contains approximately 53.8% metallic copper. The average of the market output of Basicop, however, contains 50-52% metallic copper; this may be the result of a slight lack of balance in the proportion of basic and acid copper molecules or perhaps some little water of crystallization or combined moisture.

Table 1. Concentrations of materials used to make 100 gallons of spray in experiment at Roach Orchard, Hart, Mich. 1937.

*Basicop 3 lbs., lime 8 lbs.
Basicop 3 lbs., lime 1 lb.
Basicop 1½ lbs., lime 4 lbs.
Basicop 3 lbs.
Basicop 1½ lbs.
**Cupro K 6 lbs.
**Cupro K 3 lbs.
Bordeaux 6-8-100 (Copper sulphate 6 lbs., lime 8 lbs.)
Bordeaux 3-4-100 (Copper sulphate 3 lbs., lime 4 lbs.)
Dry lime-sulphur 2 lbs., 325-mesh sulphur 4 lbs.
Dry lime-sulphur 3 lbs.
Dry lime-sulphur 10 lbs.
***Electric sulphur 4 lbs.
Liquid lime-sulphur 1 gal.
Liquid lime-sulphur 1 gal., Electric sulphur 4 lbs.
Liquid lime-sulphur 2½ gals.

*Dolomitic lime containing approximately 30% magnesium carbonate was used when lime was required in the mixtures since Rasmussen's data (7) indicated the superiority of high-magnesium lime when compared with high-calcium lime in bordeaux sprays.
**Cupro K (copper oxychloride) at strengths of 3-100 and 6-100 was included because it gave good control of leaf-spot when compared with other materials in recent years (1).
***A wettable sulphur manufactured by Stauffer Chemical Co. (Lead arsenate was omitted in the petal-fall and after-harvest sprays but was included in the two-week and four-week sprays at the rates of 3 and 2 pounds, respectively, in 100 gallons of spray mixture).

tion, August 7-8. Two days were necessary to complete the coverage of the 16 plats.

Results[3]—The first evidence of leaf-spot infection was noted on unsprayed trees about June 9; however, the earliest determination of comparative infection was not made until June 23. Infected leaves at that time showed from one to five spots a leaf (Table 2). Examination

Table 2. Percentage of leaves infected at Hart, Mich., June 23, 1937.*

Treatment	Leaves Infected	Leaves Non-Infected	Total Leaves Counted	Amount of Infection
	number	number	number	per cent
Basicop-lime 3-8-100	61	204	265	29.9
Bordeaux 6-8-100	105	275	385	38.1
Basicop-lime 3-1-100	114	255	369	44.7
Cupro K 6-100	99	219	318	45.2
Bordeaux 3-4-100	103	227	330	45.3
Basicop-lime 1½-4-100	128	251	379	50.9
Basicop 3-100	157	298	455	52.6
Cupro K 3-100	154	271	425	56.8
Dry lime-sulphur 2 lbs., 325-mesh sulphur 4 lbs.—100	132	232	364	56.8
Liquid lime-sulphur 2½-100	145	249	394	60.9
Dry lime-sulphur 10-100	134	220	354	60.9
Basicop 1½-100	195	304	499	64.1
Liquid lime-sulphur 1-100	147	199	346	73.8
Dry lime-sulphur 4-100	168	222	390	75.6
Electric sulphur 4-100	156	200	356	78.0
Liquid lime-sulphur and Electric sulphur (1-4-100)	163	207	370	78.7
Check tree	—	—	—	98.0

*Counts were made on four representative trees in each plat.

[3]Results of another experiment show that the first primary infection was established with a rain on May 21.

of these data shows that infections were well established on all plats regardless of the spray materials used. These infections do not indicate the amount of defoliation that occurred later in the season. Infections were checked in the copper-treated plats but were never completely checked in the sulphur-treated plats. The latter plats, later, showed periodic waves of defoliation as a result of leaf-spot disease.

The spray and rainfall chart (Fig. 1) shows that the applications were not well timed with reference to rains. The season's rainfall was sufficiently distributed to produce abundant periodic infections throughout the season on those trees not properly protected. Yellowing of the leaves and resultant defoliation on trees sprayed with inefficient materials appeared approximately 10 days after each rain during which an infection occurred.

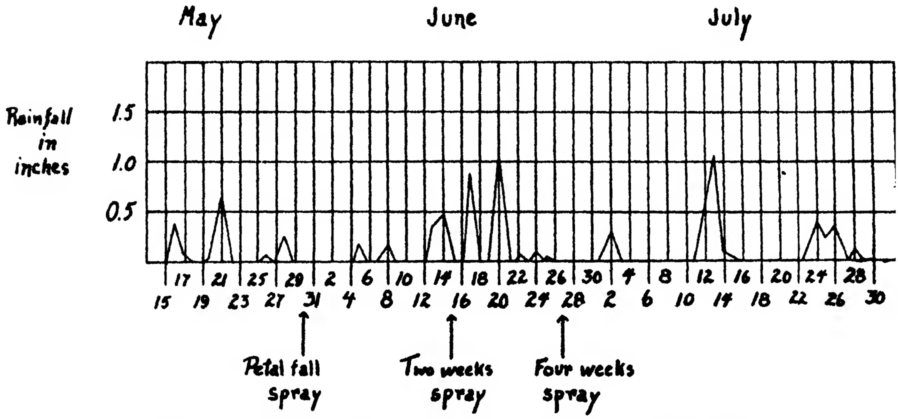

Fig. 1. Rainfall chart and spray schedule at Hart, 1937.

In general, the copper compounds controlled leaf-spot satisfactorily. With the exception of the plats treated with the weaker concentrations of Basicop, no defoliations due to leaf-spot infection occurred on the copper-treated plats; however, several light waves of defoliation because of copper injury occurred at different times.[4]

Since the sulphur treatments failed to control the disease, these treatments were abandoned in the after-harvest applications, and copper treatments using Basicop 2-2-100 were substituted. These sprays checked the disease and reduced further infections to a minimum.

Final defoliation counts were made September 25 (Table 3, Figs. 2, 3). With the two weaker concentrations of Basicop (1½-4-100 and 1½-100), control of leaf-spot was unsatisfactory although superior to that obtained from the use of lime-sulphur. A yellowing of certain leaves considered due to copper injury was noted on both plats. The determining factor of defoliation on the remainder of the copper-sprayed plats was copper injury as further leaf-spot infection was negligible.

[4]These varied according to the treatment of the plat. No data will be presented on the amount and type of copper injury other than final defoliation counts made September 25.

Fig. 2. Trees in plat sprayed with liquid lime-sulphur 2½-100.
Hart, Mich., Oct. 8, 1937.

**Fig. 3. Comparative treatments. Left, lime-sulphur 2½-100; right, bordeaux 6-8-100.
Hart, Mich., Oct. 13, 1937.**

Table 3. Comparative defoliation at Hart, Mich., Sept. 25, 1937.

Treatment	Leaves Missing	Leaves Present	Total Leaves Counted	Representative Trees Sampled	Amount of Defoliation
	number	number	number	number	per cent
Basicop 3-8-100	110	1,662	1,772	5	6.2
Bordeaux 3-4-100	245	1,981	2,226	5	11.0
Bordeaux 6-8-100	293	1,684	1,977	5	14.8
*Basicop 3-8-100	369	1,742	2,111	6	17.4
*Bordeaux 3-4-100	332	1,486	1,818	6	18.2
*Cupro K 3-100	325	1,146	1,471	4	22.0
*Bordeaux 6-8-100	481	1,676	2,157	6	22.2
*Cupro K 6-100	192	620	812	3	23.6
Basicop 3-100	1,169	3,393	4,562	12	25.6
Cupro K 3-100	534	1,301	1,835	5	29.1
Basicop 3-1-100	1,110	2,427	3,537	10	31.3
Cupro K 6-100	407	879	1,286	3	31.6
Basicop 1½-100	1,255	2,523	3,778	9	33.2
Basicop 1½-4-100	1,433	2,448	3,881	12	36.9
Dry lime-sulphur 10-100	1,889	921	2,810	8	67.2
Liquid lime-sulphur 2½-100	2,816	801	3,617	9	77.8
Unsprayed control	370	6	376	1	98.4

*Received no after-harvest application.

If comparisons are made between early infections and final defoliations (Tables 2 and 3, respectively), the percentage defoliation recorded for the sulphur-sprayed trees on September 25 is similar to the percentage of infection with leaf-spot recorded on June 23. That also was true for the unsprayed check plats. On the other hand, the copper-sprayed trees lost fewer than one-half their leaf-spot-infected leaves. That indicates that the copper-containing materials can destroy infection without causing leaves to drop. [Previously noted by Cation (1).] It is worthy of note, however, that lime-sulphur as used in this experiment also destroyed many of the infections without causing the leaves to drop. Much of the defoliation on the sulphur-treated plats apparently was due to the lack of protection between the four-week and the after-harvest spray; those plats showed 67 to 77 per cent defoliation (Figs. 2, 3).

Three-Spray Compared with Four-Spray Program[5]—A four-spray program of Basicop and lime of the concentration of 3-8-100 was superior to the other treatments (Fig. 4). Trees sprayed with this material[6] showed no perceptible injury and gave satisfactory control of leaf-spot. Basicop 3-100, without lime, which showed a final defoliation count of 25.6 per cent, was unsatisfactory because of resulting copper injury; repeated examinations, however, showed no viable leaf-spot lesions.

Treatments with Basicop and lime at 3-8-100, bordeaux 3-4-100, and

[5]For the after-harvest treatments with copper compounds, the plats treated with Basicop 3-8-100, Cupro K 3-100, Cupro K 6-100, bordeaux 3-4-100, and bordeaux 6-8-100 were divided into two portions of six trees each. One-half of each plat was given the after-harvest spray while the other half received no application. This was done to determine the effect of a three-spray program on the control of the leaf-spot and on the amount of copper injury.

[6]It is evident from the defoliation on this plat that one pound of lime was insufficient to correct copper injury. Since intermediate concentrations of lime with Basicop were not tested, the optimum amount of lime to use with 3 pounds of Basicop for 100 gallons of spray remains undetermined but is between 1 and 8 pounds.

Fig. 4. Trees in plat sprayed four times with Basicop-lime 3-8-100. Hart, Mich., Oct. 13, 1937.

bordeaux 6-8-100 applied as a three-spray program resulted in more defoliation than when applied as a four-spray program. The opposite was true with Cupro K applied at strengths of 3-100 and 6-100; with those concentrations, three sprays gave less defoliation than four. The defoliations were due to copper injury and not to lack of leaf-spot control.

Size of Fruit—It is recognized that spray materials may affect the size of the fruit. Dutton and Wells (2) stated that with the use of bordeaux severe dwarfing of fruit occurred. Keitt, *et al.* (3) found that defoliation before harvest sometimes results in an increase in the size of the fruit and that condition seemed apparent on some of the plats in this experiment, particularly on those plats in which unsatisfactory leaf-spot control was obtained by the use of weak sulphur compounds. Rasmussen (6) showed conclusively, however, that the increased size of fruit on liquid lime-sulphur-sprayed trees is not necessarily due to defoliation when compared with those trees sprayed with bordeaux. He also found that trees sprayed with certain copper compounds of low solubility produced fruit at least equal in size to fruit on trees sprayed with liquid lime-sulphur and superior in size to fruit on trees sprayed with bordeaux.

To determine the effect of the various sprays on the size of fruit, 25 cherries were similarly selected and picked from each quarter of the tops of six representative trees in each plat. One hundred cherries were thus chosen from each tree, making a total of 600 cherries used

Table 4. Comparative fruit size determinations taken at Hart, Mich., July 26, 1937.

Treatment	Total Weight of 600 Cherries*	Average Weight of 100 Cherries
	grams	grams
Liquid lime-sulphur (1 gal.) and 4 lbs. Electric sulphur—100	2,291	381.8
Liquid lime-sulphur 1 gal.—100	2,289	381.5
Basicop 3-100	2,286	381.0
Cupro K 3-100	2,285	380.8
Electric sulphur 4 lbs.—100	2,283	380.5
Liquid lime-sulphur 2½-100	2,219	269.5
Basicop 1½-100	2,199	366.5
Basicop 3-8-100	2,177	362.8
Basicop 3-1-100	2,165	360.8
Cupro K 6-100	2,127	354.5
Dry lime-sulphur (2 lbs.) and 325-mesh sulphur (4 lbs.)—100	2,083	347.1
Basicop 1½-4-100	2,071	345.1
Bordeaux 3-4-100	2,031	338.5
Dry lime-sulphur 10 lbs.—100	2,017	336.1
Bordeaux 6-8-100	1,747	291.1

*100 cherries were picked from each of six representative trees in a plat.

in each determination. Tabulated results for comparative fruit size are shown in Table 4. Definite dwarfing in the bordeaux-sprayed plat of 6-8-100 concentration was readily detected by casual observation[7], which was shown in the actual count and is illustrated in Fig. 5. Fruit of trees sprayed with Basicop compared favorably in size with that from trees sprayed with other copper compounds and with liquid lime-sulphur.

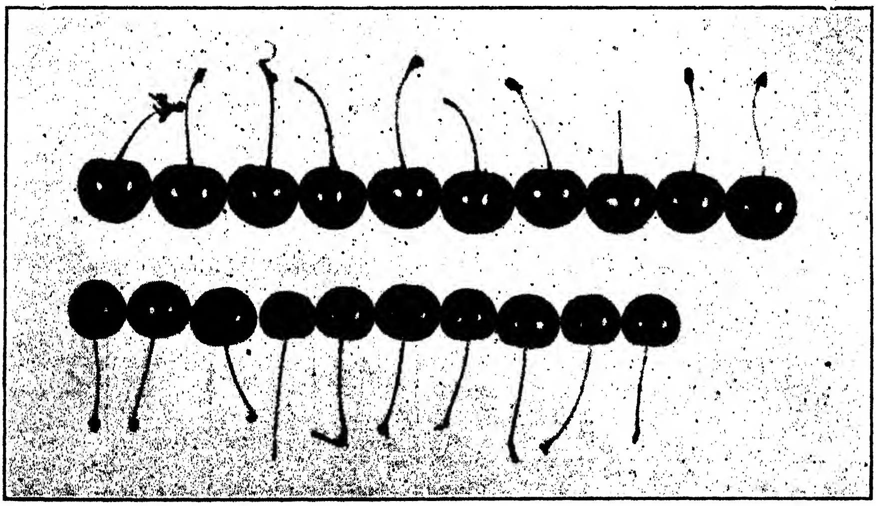

Fig. 5. Comparative size of fruit. Upper row, from trees sprayed with Basicop-lime 3-8-100; lower row, from trees sprayed with bordeaux 6-8-100. Hart, Mich., July 25, 1937.

[7]This dwarfing effect of bordeaux was not observed in an experiment at the McClary orchard, which will be discussed later.

Residual Copper on Leaf Samples—Plats receiving the four-spray program retained a higher percentage of residual copper in each instance when compared with plats given a three-spray program of the same materials and concentrations (Table 9). One disk was taken from each leaf, using a one-square-centimeter punch. Analyses were determined on the basis of 100 disks from each plat. Since no direct correlation can be drawn between the amount of residual copper and the amount of defoliation due to copper injury, it appears that the chemical character of the residual-copper complex may be the determining factor in the amount of defoliation. In addition, the results indicate to some degree the weather-resisting qualities of the various fungicides.

Field Orchard at Shelby

The experiment at the Field Orchard at Shelby consisted of three plats of 18 trees each. The seasonal spray program consisted of four applications—three pre-harvest and one after-harvest. The petal-fall application was made June 1; the two-week application, June 16; the four-week, June 28; and the after-harvest spray, August 13.

Materials used were: Basicop and lime 3-1-100; Cupro K 6-100; and lime-sulphur (liquid) 2½-100. For the two-week and four-week applications, 3 and 2 pounds of lead arsenate, respectively, were added. Lead arsenate was not used in the petal-fall nor in the after-harvest applications.

Results—Although no counts were taken, infection was relatively heavy throughout the latter part of the season. The copper materials gave satisfactory control of leaf-spot; defoliation was noted on the plat treated with lime-sulphur.

Copper injury was noted on both the Basicop-treated plat and the Cupro K-treated plat, resulting in several light defoliations. Despite these defoliations, the two plats presented a much better appearance at the end of the season than did the lime-sulphur-treated plat. The actual percentage of defoliation was not determined.

One hundred cherries were picked from each of 12 to 15 representative trees in each plat on July 31. No appreciable difference in fruit size could be determined for the three plats (Table 5).

Table 5. Fruit size determinations at Field's Orchard, Shelby, Mich., July 21, 1937.

Treatment	Trees Sampled	Cherries Picked	Total Weight	Average Weight of 100 Cherries
	number	number	grams	grams
Basicop 3-8-100	14	1,367	6,379.4	462.2
Cupro K 6-100	15	1,500	6,837.0	450.3
Liquid lime-sulphur 2½-100	12	1,191	5,465.2	455.8

Smith Orchard at Omena

Three plats of approximately 50 trees each composed the block in the Thomas Smith Orchard at Omena. A program of four applications was conducted. Materials used were: Basicop and lime 1½-1-100; Cupro K 3-100; and liquid lime-sulphur 2½-100.

Results—The season was abnormally dry at Omena and no leaf-spot infection was noted even on the unsprayed control tree. Although the amount of defoliation was not determined there was little difference in the appearance of the three plats at the end of the season; if anything, the lime-sulphur-sprayed plats appeared better than did the plats sprayed with the copper materials.

Cherry size determinations of fruit from representative trees in each plat were taken. The fruit from the copper-treated trees was slightly smaller than that picked from the lime-sulphur-treated trees (Table 6).

Table 6. Fruit size determinations at the Thomas Smith Orchard, Omena, Mich., July 31, 1937.

Treatment	Representative Trees Sampled	Cherries Picked	Total Weight	Average Weight of 100 Cherries
	number	number	grams	grams
Lime-sulphur 2½-100	20	2,000	6,782	339.1
Basicop 1½-1-100	18	2,000	6,213	310.6
Cupro K 3-100	20	2,000	6,199	309.9

McClary Orchard at Empire

The three adjacent plats used in the McClary Orchard at Empire consisted of approximately 60 trees each. The spray materials[8] were: Basicop and lime 2-1-100; Cupro K 4-100; and bordeaux 4-5-100. The sprays were applied as follows: Petal-fall application June 4; two-week spray, June 18; and the four-week spray, June 30. The trees were also dusted with sulphur dust following a bruising wind storm to prevent possible brown-rot infection.

Results—Leaf-spot infection was practically lacking in the McClary experiment. This can be attributed partly to the lack of initial inoculum because of the excellent control from use of bordeaux sprays the previous season. For this reason, records of the comparative control value of the different compounds were not obtainable.

Only one wave of copper injury was observed and recorded[9] in the McClary block, August 8. (That occurred about two weeks after a severe wind of July 25.) At that date the Cupro K-sprayed plat showed

[8]Arsenate of lead was added in the second and third sprays of Basicop and Cupro K, and in the second spray only of bordeaux. The third (four-weeks) spray was not applied to the bordeaux-treated plat owing to an unforseen shortage of material.

[9]The McClary block was not under continuous observation although it was visited frequently.

Table 7. Injury counts at McClary Orchard, Empire, Mich., Aug. 8, 1937.

Treatment	Spurs Counted	Spurs Showing Yellow Leaves	Spurs Showing Yellow Leaves
	number	number	per cent
Basicop 2-1-100	200	6	3.0
Cupro K 4-100	460	123	26.0
Bordeaux 4-5-100	619	82	13.0

conspicuously more injury than did the Basicop and bordeaux-sprayed plats (Table 7). If this injury were considered to be the result of soluble copper entering wind-bruised leaves, the lack of injury on the Basicop-sprayed plat might be attributed to a more sheltered position. This would not be true, however, for the bordeaux-sprayed plat. The remainder of the 90-acre cherry orchard, was sprayed with Basicop 3-6-100 and showed little injury. Although counts were not made late in the season, only slight defoliation was apparent from casual observation on any of the treatments, even as late as October 13.

Fruit Dwarfing—Determination of fruit size at the McClary Orchard (Table 8) is significant in that no dwarfing due to bordeaux could be ascertained. This is at variance with results obtained at the Roach Orchard at Hart and with results previously published by other investigators where three pre-harvest sprays were applied. Dutton (2) and Rasmussen (6), who found that bordeaux distinctly depressed the fruit size, took their data from trees receiving three pre-harvest sprays. Keitt's, *et al.*, results (4) indicate the dwarfing effect of bordeaux to be slight, but his records were taken from trees receiving two pre-harvest sprays.

Table 8. Fruit size determinations at the O. R. McClary Orchard, Empire, Mich., July 30, 1937.

Treatment	Applications	Cherries Weighed	Total Weight	Average Weight of 100 Cherries
	number	number	grams	grams
Bordeaux 4-5-100	2	2,400	9,475.0	394.7
Basicop 2-1-100	3	2,400	9,376.0	390.6
Cupro K 4-100	3	2,400	8,644.0	360.0
Control (unsprayed)	0	600	2,714.0	452.3

As the third bordeaux spray had been omitted at the McClary plat and as no fruit dwarfing could be detected, the results naturally suggest that the third spray is responsible for the dwarfing effect on fruit sprayed with bordeaux. This hypothesis is substantiated by several Michigan cherry growers who consistently use only two pre-harvest

sprays of bordeaux and who state they find no fruit-dwarfing effect from that procedure.

Summary

1. Results of one year's experiments comparing Basicop with other spray materials are presented.

2. Basicop-lime 3-8-100 controlled leaf-spot satisfactorily with little perceptible injury. Basicop with one pound or less of lime was unsatisfactory in some of the experiments owing to copper injury; Basicop 1½-100 did not give satisfactory control of leaf-spot, although much superior to liquid lime-sulphur 2½-100.

3. Liquid lime-sulphur 2½-100 and weaker concentrations of sulphur failed to control leaf-spot with the number and timing of applications used in several of the experimental blocks.

4. Bordeaux 3-4-100 and 6-8-100 controlled leaf-spot satisfactorily although these sprays showed a tendency to dwarf the fruit in proportion to the concentration used. Bordeaux 4-5-100 applied in two pre-harvest sprays did not dwarf the fruit in one experiment.

5. Basicop 3-8-100 showed no noticeable tendency to dwarf the fruit when compared with other materials used in these experiments.

Acknowledgments

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Table 9. Analysis of residual copper deposit on leaf samples collected Oct. 9, 1937.

Treatment	Amount of Copper per 100 Disks	Amount of Copper by Weight
	grams	per cent
Bordeaux 6-8-100	.00255	.231
Cupro K 6-100	.00099	.117
**Bordeaux 6-8-100	.00107	.109
Bordeaux 3-4-100	.00080	.092
**Cupro K 6-100	.00052	.063
Basicop 3-100	.00050	.062
**Bordeaux 3-4-100	.00054	.054
Basicop 3-8-100	.00050*	.050
Cupro K 3-100	.00054	.048
**Basicop 3-8-100	.00042	.043
Basicop 1½-4-100	.00035*	.036
**Cupro K 3-100	.00034	.034
Basicop 1½-100	.00026	.025
***Control tree	.00027	.018
Basicop 3-1-100	No record	

*These disks were not counted but the average weight of 100 disks in the remaining samples were used to figure the number of disks.
**Received but three pre-harvest sprays.
***Received one after-harvest spray of Basicop 2-2-100.

Literature Cited

1. Cation, Donald—New Copper Sprays for Control of Leaf-spot. Mich. Agr. Exp. Sta. Quart. Bul. *19* (3): 123-132. 1937.
2. Dutton, W. C. and Wells, H. M.—Some Physiological Effects of Bordeaux. Proc. Am. Soc. Hort. Sci. *21:* 277-281. 1923.
3. Keitt, G. W., Blodgett, E. C., and Magie, R. O.—Progress of Studies of the Epidemiology and Control of Cherry Leaf-spot. Phytopath. *26:* 97. 1936. (Abstract.)
4. Keitt, G. W., Blodgett, E. C., Wilson, E. E., and Magie, R. O.—The Epidemiology and Control of Cherry Leaf-spot. Wisc. Agr. Exp. Sta. Res. Bul. 132. 1937.
5. McNew, G. L. and Bliss, D. E.—Control of Cherry Yellow-leaf on Nursery Stock. Iowa Agr. Exp. Sta. Bul. 332. 1935.
6. Rasmussen, E. J—Effect of Some Copper and Sulphur Fungicides on the Tree and Fruit of Montmorency Cherry. Mich. State Agr. Exp. Sta. Quart. Bul. *19* (3): 132-142. 1937.
7. Rasmussen, E. J.—A Progress Report on Comparisons of High-calcium and High-magnesium Limes in Bordeaux on Sour Cherry, and in Zinc-lime and Iron-lime Mixtures on Peach. Proc. Am. Soc. Hort., Sci. *34:* 279-284. 1937.

COMPARISONS OF FUNGICIDES FOR CONTROL OF CELERY LEAF BLIGHTS

RAY NELSON AND RALPH W. LEWIS
BOTANICAL SECTION

Since control of Fusarium yellows has been achieved by the development of resistant varieties leaf blights are the most destructive diseases of celery in Michigan. Early blight causes serious damage to the summer crops in warm, humid seasons, while the late blights are most destructive during wet, cool weather. In the districts of intensive culture where celery has been grown continuously for many years, these diseases are a hazard to profitable crop production which the average grower has not been able to overcome. There the factors which influence the development of leaf diseases are operative to a greater degree than in sections where culture is less intense or where the crop has been grown fewer years. Even on farms where it is possible to use power equipment to apply dusts or sprays many growers have not successfully controlled these diseases when climatic conditions are conducive to the occurrence of epidemics. The season of 1937 furnishes an illustration of the devastating effect of celery blights on the Michigan crop in an epidemic year. The injurious effects of excessive rainfall in some sections makes it difficult to estimate the damage caused by leaf diseases alone. A conservative statement would be that production was reduced at least one-third. The U. S. Department of

Agriculture has estimated the value of the Michigan celery crop marketed in 1937 at approximately $2,000,000. This would indicate a loss of $1,000,000 to Michigan celery growers, at least three-fourths of which can be attributed to the effect of leaf blights.

In previous reports[1] it was shown that copper dusts when properly used are effective fungicides for the prevention of these diseases. Failure to control leaf blights is commonly due to certain weaknesses in the dusting and spraying programs which have been discussed previously and need not be emphasized again. In some sections the standard method of blight control has been by dusting with the 20-80 copper sulphate-lime dust. Where this method has been used for many years, as in Kalamazoo county, excessive amounts of lime have been added to the soil. The average grower applies from 150 to 300 pounds of this dust per acre each season. Of this amount four-fifths is a highly active form of lime. As a result of repeated annual applications of this dust the soil reaction has been moving constantly toward the alkaline side and creating a condition unfavorable for the growth of celery. Side-dressing with ammonium sulphate has retarded somewhat this accumulation of alkali but the quantities used have not been sufficient to neutralize the annual accumulation of lime. The need for applications of sulphur, or other soil amendments, to make the soil reaction more favorable for celery is already evident in many fields in Kalamazoo county and in other sections where the 20-80 dust has been used for some time. To prevent further additions of excessive amounts of lime experiments were started in 1936 with lime-free dust fungicides. These experiments were continued in 1937 and this report shows the results achieved by their use and also by substitutes for Bordeaux mixture in plantings where spraying is practiced instead of dusting.

Dusting Experiments

The dusting experiments were conducted on two farms at Comstock; on one farm the crop dusted was ready for market in midsummer and was exposed to infection mostly by the early blight fungus *(Cercospora apii)*, while the other was a late summer crop and was not marketed until late blight *(Septoria apii-graveolentis)* had become well established. Weather conditions were very favorable for both diseases which caused serious damage in nearly all commercial plantings. Very few growers succeeded in controlling either disease with dusts or sprays and the degree of control obtained with the materials and equipment used in these experiments probably represents the maximum benefit to be expected from them under similar seasonal conditions.

On the Knott farm the celery planting was supplied with water from overhead lines. Leaf blights had caused heavy losses annually for several years. The grower had never succeeded in checking the development of blight and had abandoned all efforts at control. On the Wanders farm leaf blights were less serious since the high water table made it unnecessary to use irrigation. Early blight had ruined

[1]Nelson, Ray and Cochran, L. C. Copper dusts control celery early blight. Mich. Agr. Exp. Sta. Quar. Bul. **18:** 163-169. 1936.

Nelson, Ray and Lewis, Ralph W. Comparative effectiveness of copper dusts in the control of celery leaf blights in 1936. Mich. Agr. Exp. Sta. Quar. Bul. **19:** 159-162. 1937.

the 1935 crop but late blight had not become a serious factor during any previous season. The systems of culture were very similar on each farm. The plants were set in rows 30 inches apart and spaced 4 inches in the rows which were 40 rods long. Each 40-rod plat was divided into 20 two-rod sections which made it possible to use four replications of each fungicide and of the undusted checks. The seedlings had not been dusted or sprayed in the seedbeds and were about 3-4 inches tall when the first applications were made. On the Wanders farm no blight was evident on the plants at the time of the first application but in the Knott planting early blight was well established throughout all the plats and was causing serious damage in adjacent plantings.

For comparison with the 20-80 dust three others which carried no lime as diluents were used. These included: (1) Basicop, with basic copper sulphate as the fungicidal ingredients and talc as a filler (The Sherwin-Williams Co.); (2) Cuprocide, with red copper oxide as the fungicide added to kaolin and other inert fillers (Röhm and Hass); (3) "Mike" sulphur, microscopically fine sulphur, undiluted, (Dow Chemical Co.). The 20-80 copper sulphate-lime dust contains 7% pure copper and the other copper fungicides also carried approximately this same quantity. Hand-operated dusters were used and so far as possible equal weights of each dust were used. The different densities and flowing qualities of the materials, however, made it impossible to achieve quantitatively equal coverage of the plants. The dusts were applied in the early morning or late evening when the presence of dew on the plants made the fungicides adhere better to the leaves. The dusts were applied at the rate of approximately 35-40 pounds per acre at each application. At this rate the amount of copper deposited on the plants per acre is approximately equivalent to that in 100 gallons of bordeaux mixture and is considered the minimum quantity necessary to obtain good coverage. The 20 two-rod plats were arranged with a random distribution of each dust treatment and of the undusted checks.

Rains were frequent during the summer and it was necessary to dust often to keep the plants protected from infection. The dusting schedules on the two farms were as follows:

Wanders farm: June 24, 29, July 2, 6, 12, 16, 21, 28, Aug. 3, 6, 10, 13, 19. Total, 13 applications.

Knott farm: July 2, 7, 13 16, 21, 28, Aug. 3, 6, 10, 13, 19, 24, 31, Sept. 2, 9, 14. Total, 16 applications.

Method of Taking Records—Just before the plats were harvested representative samples of leaves of approximately the same age were taken from each plat. One leaf was removed from each of 10 plants selected at random in every plat. These leaves were dried between blotters in a plant press. In January the terminal and one lateral leaflet were removed from each leaf and the number of blight spots counted. For each dusted plat this entailed the counting of spots on 20 leaflets or on a total of 80 leaflets for each treatment and the check. It was not always possible to use the maximum number of leaflets; some were so badly affected with blight that the number of lesions could not be determined. The leaves from the undusted and from the sulphur plats were most seriously affected and the records had to be taken from a much smaller number of leaflets than in the other plats.

After recording the number of lesions present on the leaflet its area was determined photometrically with the apparatus devised by Hibbard, Grigsby, and Keck.[2] The total surface area of the leaflets was compiled from these data and the number of lesions per square centimeter was calculated as well as the average number on each leaflet. Since infection may take place through either the upper or lower epidermis of the leaflet the actual area exposed to blight spores was 2x that determined with the photometric equipment. Because the leaflets varied considerably in size the ratio $\frac{\text{total surface area}}{\text{total no. lesions}}$ gives the most accurate comparison of the effectiveness of fungicides in preventing infection.

Table 1. Celery blight control and yields in plats dusted with various fungicides, Comstock, Mich., 1937. Summarized data from plats consisting of 5 or 6 rows, 2 rods long, replicated 4 times.

Treatment	No. of Leaflets Used for Lesion Counts	Sum of Surface Areas, cm²	Total No. of Blight Spots	Average No. of Spots per Leaflet	Average No. of Spots per cm²	Yield: Net Weight, lbs.
WANDERS FARM						
20-80	80	2,474	145	1.8	0.06	*390.5
Cuprocide	80	2,586	238	3.0	0.09	293.0
Basicop	80	2,488	425	5.3	0.17	364.5
"Mike" Sulphur	78	2,402	1,080	14.0	0.45	298.5
Undusted	70	1,466	1,916	27.3	1.31	190.5
KNOTT FARM						
20-80	74	2,456	286	3.7	0.11	*867.0
Cuprocide	74	2,502	316	4.3	0.12	690.0
Basicop	72	2,676	380	5.3	0.15	690.0
"Mike" Sulphur	72	2,544	649	9.0	0.25	804.0
Undusted	40	1,422	434	10.8	0.30	552.0

*Yield data, Wanders farm, from 20 2-rod rows, harvested August 30; Knott farm, 24 2-rod rows, harvested September 28.

Yield records were taken at the time of harvest and consisted of net weights of the stalks from each plat after they were trimmed and ready for packing. The weights of the stalks varied considerably from the individual plats, not only because of differences in the amounts of blight present, but also because of slight variations in the contour of the land which had an influence on drainage, and consequently, on the amount of injury from excessive wetness of the soil in August. Because of the randomized distribution of the treatments in the plantings, the summarized records of the four plats on each farm tend to compensate for these slight differences in soil conditions. Since excessive rainfall, however, caused some damage in all plantings the data on blight control are more indicative of the comparative value of the dusts than the yield records. The only exception is the sulphur dust, which had an influence on yield far in excess of the possible

[2]Hibbard, R. P., Grigsby, B. H., and Keck, W. G. A low light intensity photoelectric device for the determination of leaf areas. Papers of the Mich. Acad. Sci. Arts and Letters **23:** 1937 (1938).

benefit from its comparatively poor fungicidal action. The data on blight control and yield are summarized in Table 1.

On both farms the 20-80 copper sulphate-lime dust controlled both early and late blight better than the other fungicides. The Cuprocide dust ranked second and Basicop third. "Mike" sulphur gave comparatively poor control of disease in both tests but despite the blighted condition of the plants in the sulphur plats the yields were relatively high. On the Knott farm, sulphur was only one-third so effective as either Cuprocide or Basicop in preventing infections but the net weight of trimmed stalks was greater from the rows dusted with sulphur. This indicates that there was a beneficial effect from the sulphur other than its fungicidal action. While no tests of soil reaction were made in the plats at the end of the season, it is probable that this effect of sulphur was from its acidifying action. The "Mike" sulphur particles are extremely small and thus, very active in their influence on soil reaction. The quantity applied on the Wanders farm would approximate 450 pounds per acre and on the Knott farm 550 pounds. These quantities of sulphur undoubtedly had a marked effect in shifting the pH of the soil to a point where the increased acidity was more favorable for the growth of celery.

Spraying Experiments

The spraying tests were conducted at Comstock with celery ready for market in late September and early October and at Decatur with a late crop grown for cold storage. For several years very little spraying has been done at Decatur because of mediocre control of blight obtained. Antiquated spray machines are rusting in sheds and in the open, reminiscent of days when spraying was a regular part of the cultural program. In blight years disease has always caused severe damage in the Decatur district and plats were established there in 1936 to investigate the cause of the reported failure of standard fungicides to prevent leaf diseases. Scald, following heavy rains and high temperatures, ruined the crop in 1936 and no data were obtained. The aim of the tests at Comstock and at Decatur was to compare the effciency of some of the newer fungicides with the standard 8-12-100 bordeaux mixture. If some of these newer fungicides are as effective as bordeaux mixture there are certain advantages to be gained from their use—savings of time and labor in mixing. The lime used in making bordeaux mixture probably adds some alkali to the soil each season but the amount is small compared with that in the 20-80 dust and the effect upon soil reaction is slight. If, however, some equally effective substitute can be found that does not require the use of lime it would be widely used.

Haefner Farm, Decatur—The spraying experiments at Decatur were conducted in a 10-acre field of tall strain Golden Self-Blanching celery on the farm of Carl Haefner. Celery had not been grown in this field since 1934 and the overwintering of blight fungi in celery refuse was eliminated as a factor in initiating the primary infections. This field, however, adjoined other plantings that were not sprayed and in which early blight developed very seriously and furnished abundant inoculum during the summer to infect the plants in the experimental plats. The

rows were 80 rods long and the plants were set 4-5 inches apart in rows 4 feet apart. The sprays were applied with a 4-row John Bean sprayer powered by a take-off connection to the tractor. A pressure of 300-350 pounds was maintained. The materials tested were:

Standard 8-12-100 bordeaux mixture
Cupro-K (Copper oxychloride) 25% copper. Röhm and Haas
Cuprocide-54 (Copper oxide plus sticker) 54% copper. Röhm and Haas
Basicop (Basic copper sulphate) 52% copper. The Sherwin-Williams Co.
"Mike" sulphur (Superfine wettable sulphur) Dow Chemical Co.

In making up the copper sprays the quantity of basic material used supplied an amount of copper equivalent to that in the 8-12-100 bordeaux mixture. One hundred gallons of this spray contains 2 pounds of pure copper. To supply an equal amount, 8 pounds of Cupro-K, 4 pounds of each of Cuprocide-54 and Basicop were used in making 100 gallons of spray. Powdered copper sulphate and hydrated spray lime were used for making bordeaux mixture. No lime or other supplements were used with the insoluble copper fungicides.

Each plat consisted of four 80-rod rows and the treatments were replicated once. Thus, approximately 4/5-acre of celery was sprayed with each fungicide and with the unsprayed check rows the experimental plats included about 5 acres. Because of frequent rains a comparatively large number of applications were needed to protect the plants. The first application was made when the plants were 3-4 inches tall but no blight infections were apparent. The sprays were applied at a uniform rate of 100 gallons per acre at each application. No prearranged schedule of applications was followed, they were based entirely on weather conditions and were made as follows: July 14, 16, 23, 28, Aug. 4, 10, 13, 18, 28, 30, Sept. 8, 14. It will be noted that no applications were made from August 18 to August 28. This was due to excessively heavy rains during that 10-day period which made it impossible to work in the field.

Bacterial blight *(Bacterium apii)* appeared on the plants in the unsprayed rows and on those sprayed with sulphur after the fifth application. This leaf disease has not been observed in Michigan celery fields for at least 15 years and its occurrence in this planting where celery trash is eliminated as a source of the organism can undoubtedly be attributed to infected seed. The lower leaves of infected plants were conspicuous by their yellow color and the disease spread rapidly during August. Since the sulphur and unsprayed plots involved about 1 3/5 acres the grower was alarmed at the increase of the disease and feared for the loss of this portion of his crop. Because of the large quantity of celery threatened three of the four check rows in each plat were sprayed with bordeaux mixture at the time of the ninth application, August 28. This was the first spray applied after the heavy rains of August 19-20. Two check rows remained unsprayed during the remainder of the season. Before bordeaux mixture was applied to these check rows a record was taken of the amount of bacterial blight in all the plats. In taking the records a plant was inspected closely every 20 paces in one row of each of the replicated plats. This necessitated examination

of 48 plants in the two plots sprayed with each fungicide. The plants were examined for infection on the bottom, middle, and top leaves and the comparative distribution and number of lesions were used in evaluating the fungicides as protectants against infection by *Bacterium apii.* The results are shown in Table 2.

Table 2. Comparative effectiveness of various fungicides in the control of bacterial blight of celery, Decatur, Mich. Records from 48 plants in 2 80-rod rows, Aug. 25, 1937.

Treatment	Number of Plants with Bacterial Blight Lesions on:			
	No Leaves	Bottom Leaves only	Bottom and Middle Leaves	Bottom Middle and Top Leaves
Bordeaux 8-12-100	48	0	0	0
Cupro-K 8-0-100	45	3	0	0
Basicop 4-0-100	44	4	0	0
Cuprocide-54 4-0-100	41	7	0	0
"Mike" Sulphur 5-0-100	14	8	17	9
Unsprayed	21	10	13	4

All copper fungicides controlled bacterial leaf spot satisfactorily but bordeaux was most effective. Basicop and Cupro-K were less effective than bordeaux but they gave good commercial control and were superior to Cuprocide-54. "Mike" sulphur not only failed to prevent infection but actually seemed to increase the amount of blight since there were more infected plants in the sulphur plats than in the unsprayed rows. While the method of taking records may appear inadequate to furnish sufficient data from which to make this conclusion, the general appearance of the rows sprayed with sulphur showed that blight was much more severe in these plats than in the unsprayed rows.. Dye and Newhall[3] reported an increase of bacterial blight in some of their experiments with sulphur. They suggested no cause for this influence of the sulphur. Since infection of celery by *Bacterium apii* occurs through the stomata it is possible that the effect of sulphur in increasing the amount of blight in the sulphur-sprayed plants was due to an influence upon stomatal apertures.

The heavy rainfall of August 19-20 was followed by 10 days of warm and sultry weather. The plants were wet with dew until mid-morning each day and conditions were especially conducive to the development of early blight. The soft condition of the muck made it impossible to use the sprayer during the 10-day period. When the bacterial blight records were made August 25, early blight infections were very noticeable on the unsprayed plants and by September 1 the lower leaves of these plants were dying from the effects of the disease. Infections were also developing on the plants in the sulphur plats but the plants sprayed with the copper materials were comparatively free of disease. Early blight continued to spread during the first two weeks of September but was checked by lower temperatures thereafter. Scattered

[3]Dye, H. W., and Newhall, A. G. The control of bacterial blight of celery by spraying and dusting. N. Y. Agr. Exp. Sta. Bul. 429: 1-30, Figs. 1-10. 1924.

focal points of late blight infection appeared in September but the disease caused but little damage even to the unsprayed plants. Spraying was completed with the 12th application on September 14 and on September 22 the plants were banked in earth to blanch the stalks slightly before harvest.

In taking the records on comparative blight control a section of the field was chosen where the contour was uniform and where there had been no noticeable damage from the heavy rainfall in August. Leaves were collected from a cross-section of the plats and the sampling was done purely at random. The leaves were dried and records taken in January in the same way as described for the dusting plats at Comstock. The data on comparative control of blight and on yields are summarized in Table 3.

Table 3. Comparative control of celery leaf blights in plats sprayed with various fungicides, Haefner farm, Decatur, Mich., 1937. Data from duplicate 2/5 acre plots.

Treatment	No. of Leaflets Used in Making Lesion Counts	Total Surface Area of Leaflets cm^2	Total No. of Blight Spots	Average No. of Spots per Leaflet	Average No. of Spots per cm^2. Surface Area	Yield: 2/3-crates
Bordeaux 8-12-100..........	40*	1,384	111	2.8	0.08	215
Basicop 4-0-100............	38	1,178	141	3.7	0.12	210
Cuprocide-54 4-0-100........	34	1,266	137	4.0	0.11	213
Cupro-K 8-0-100............	38	1,282	212	5.6	0.16	206
"Mike" Sulphur 5-0-100......	24	504	213	9.0	0.42	203
Unsprayed.................	22	612	523	24.0	0.84	172

*The variable number of leaflets used in making lesion counts was due to the condition of the leaves collected in random sampling of the plants. The terminal and the lateral leaflet of the same age on each were used and some of these were so badly affected with blight that the number of spots could not be counted.

Bordeaux mixture gave much better control of blight than the other copper compounds. This superiority was readily apparent from a casual examination of the plats toward the end of the season. The lower leaves on the plants sprayed with bordeaux were still green and functionable to the end of the growing season while the greater number of blight spots on the plants in other plats caused a yellowing of these leaves that was in proportion to the area destroyed. The unsprayed plants were blighted so that the lower leaves were killed and lay prostrate on the soil. The plants in the sulphur plats were infected much more generally than those sprayed with the copper fungicides. The lower leaves were dead on many of these plants but the rows appeared much greener in color than those sprayed with the copper materials. The bottom leaves of plants throughout the field were yellow owing to excessive wetness of the soil in August and early September and any possible toxic effects of insoluble copper fungicides on the plants were obscured by this general chlorosis. It is possible that the better color of the plants sprayed with sulphur was due to the non-toxicity of this material as compared with the copper compounds. Basicop and Cuprocide-54 gave satisfactory commercial control of blight, but Cupro-K was somewhat less effective although it prevented any serious

development of blight. It was, however, just one-half as effective as bordeaux mixture.

Yield records were taken on the day of harvest when the trimmed celery was packed into standard 2/3-crates for transfer into cold storage. Each plat of four rows was harvested separately and packed ungraded into the crates. Yield data regarding the eight unsprayed rows were obtained in multiplying by the factor 4 the number of crates harvested from the two rows that remained unsprayed throughout the season. For all other plats the records are for the actual number of crates harvested. The highest yield was obtained from the rows sprayed with bordeaux mixture which increased production over the check rows by 25 per cent or 48 crates per acre. Cuprocide-54 increased production 23 per cent or 51 crates, and Cupro-K 20 per cent or 42 crates per acre. The sulphur-sprayed plants outyielded the unsprayed 18 per cent or 39 crates per acre. The increased yield from these rows was out of proportion to the fungicidal effect of the sulphur as measured by the reduction in incidence of infection achieved by spraying with this material. It is more difficult to account for the increase in yield here than in the dusted plots at Comstock. At the rate used at Decatur, slightly less than 100 pounds per acre was applied during the season and only a portion of that actually reached the soil. It seems unlikely, although possible because of the extremely small particle size, that the sulphur had a beneficial effect upon soil reaction. The initial reaction was about neutral and not acid enough for the best growth of celery. The small amount of active sulphur may have changed the reaction sufficiently to make the soil conditions slightly more favorable for growth. Excessive wetness of the soil after mid-August however, undoubtedly retarded or prevented oxidation of the sulphur to acid-forming radicals.

Wanders Farm, Comstock—Each plat on this farm consisted of two 40-rod rows and the treatments were replicated once. The plants were sprayed with a John Bean two-row power sprayer at a pressure of 250-300 pounds. In addition to bordeaux mixture, Basicop and "Mike" sulphur, two grades of copper oxychloride manufactured by Grasselli Chemical Co. were used. The dilutions of the copper fungicides were made to include an amount of copper equivalent to that in bordeaux mixture. The schedule of 11 applications was about the same as at Decatur, the first on July 6, the final one September 8. Very heavy rains August 17 and 18 caused serious damage in all plats and also prevented the use of the sprayer for 10 days. During that time both early and late blight became well established on the unsprayed plants and these diseases continued to spread during the rest of the season.

Records were taken in the same way as at Decatur with the yields listed as net weights of trimmed stalks. The yield data are not so significant as those on blight control, since the method of continuous harvest in this area makes it impossible to harvest all of the plats at the same time. Two weeks elapsed between the dates of harvest of some plats and the differences in yield cannot be attributed solely to differences in degree of blight control. The replicated plats were bisected by a drainage ditch and the rows of celery planted adjacent to it grew much better than those in the wetter parts of the field. In a

general way, however, the comparative yields agree very well with the actual condition of the plants with respect to blight infection. Data on comparisons of the fungicides used in these experiments are shown in Table 4.

Table 4. Comparative effectiveness of various liquid fungicides in the control of celery leaf blights, Wanders farm, Comstock, Mich. 1937.

Treatment	Average No. of Infections per Leaflet	Average No. of Infections per cm² Leaf Area	Yield: Four 40-rod Rows pounds
Bordeaux 8-12-100	23	0.72	1,665
Copper oxychloride-A 4.5-0-100	70	2.2	1,272
Copper oxychloride-B 3.5-0-100	23	0.73	1,390
Basicop 4-0-100	32	1.0	1,472
"Mike" Sulphur 5-0-100	115	4.0	1,038
Unsprayed	50	1.7	860

The larger number of blight lesions on the plants in these plats compared with those at Decatur was due to the predominance of Septoria infections which form very small spots. Bordeaux mixture gave the most effective control of leaf blights but copper oxychloride-B was only slightly less efficient. "Mike" sulphur seemed to increase the amount of blight since the lesions on the plants sprayed with this material were more than twice as numerous as those on the unsprayed plants. The yield, however, from the sulphur-sprayed plants was much greater.

The wide differences in degree of blight control obtained with the two grades of copper oxychloride cannot be explained, since equivalent amounts of copper were applied at the dilutions used. The manufacturers have reported that copper oxychloride-A supplemented with an effective spreading and sticking agent has given results superior to bordeaux in other tests. In the experiments at Decatur and at Comstock the better fungicidal properties of bordeaux mixture appeared to be due to its greater adhesiveness during rains. Examination of the plants sprayed with the insoluble materials (with a 10 X magnifier) failed to disclose any visible evidence of copper particles, while the plants sprayed with bordeaux mixture always carried an easily detectable film of fungicide. The efficiency of the insoluble copper fungicides could undoubtedly be greatly increased by the addition of a spreading and sticking agent. At Decatur Cuprocide-54 did contain such a material but its presence failed to make this fungicide equal in effectiveness to bordeaux mixture. All of the materials tested, with the exception of sulphur, can probably be modified to make them satisfactory fungicides for celery blight control. The experiments planned for 1938 include the use of these insoluble copper fungicides modified so as to increase their adhesive properties. The beneficial effect of sulphur has suggested certain combinations in the dust fungicides which may lead to the development of new mixtures that are equally as effective as the 20-80 copper-lime material without its objectionable features. With the addition of suitable materials to increase the adherent properties of dusts like Basicop and Cuprocide such

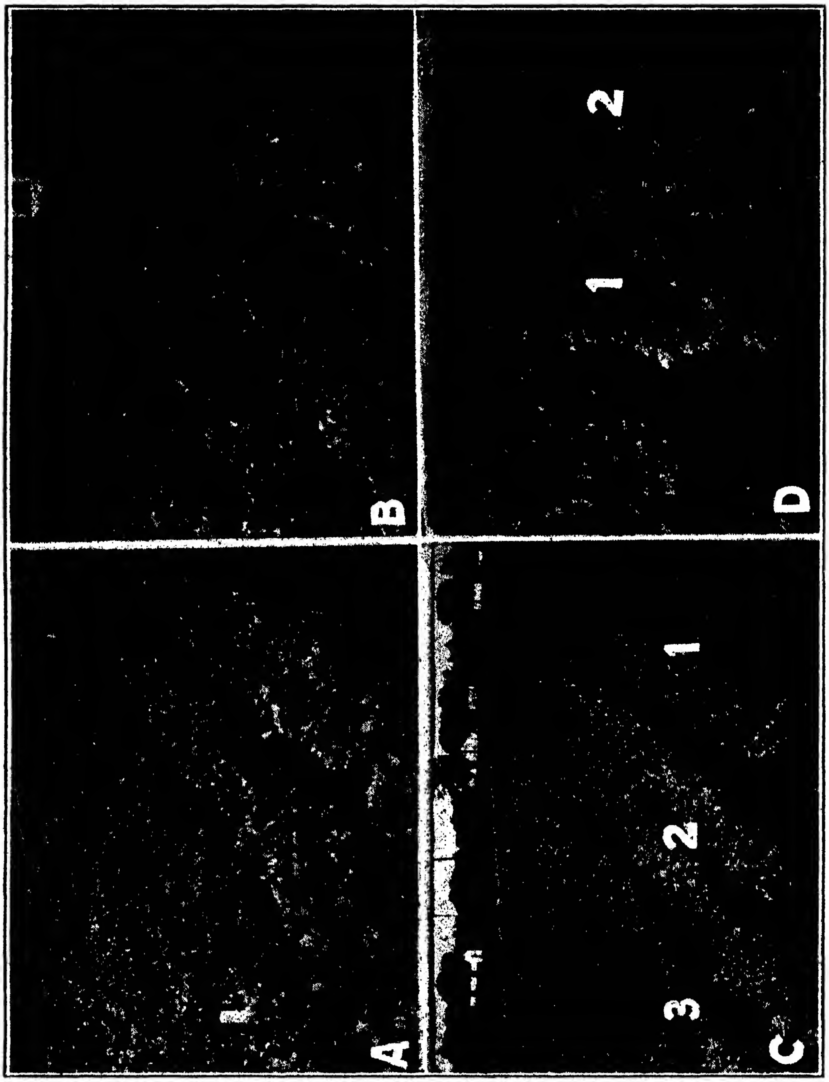

Figure 1.

(A) Six 2-rod undusted rows, Knott farm, Comstock. Yield, net wt. 141 lbs.

(B) Six rows dusted with 20-80 copper sulphate-lime dust. Yield, 213 lbs.

(C) Spray plats, Wanders farm, Comstock.

1. Two rows sprayed with copper oxychloride-B. Yield, net wt. 918 lbs.
2. Two rows sprayed with 8-12-100 bordeaux mixture. Yield, 946 lbs.
3. Two unsprayed rows. Yield, 488 lbs.

(D) Spray plats, Haefner farm, Decatur.

1. Four 80-rod rows (left) sprayed with Basicop 4-0-100. Yield 100 2/3-crates.
2. Four 80-rod rows (right) unsprayed. Dead leaves at base of plants indicate blight development. Yield 84 2/3-crates.

fungicides will be accepable substitutes for the standard 20-80 dust that carries such an objectionable excess of lime. Until effective substitutes have been prepared and thoroughly tested, however, 8-12-100 bordeaux mixture and the 20-80 copper sulphate-lime dust should be used by Michigan celery farmers for the control of leaf blights.

BEEF FEEDING COSTS AND RETURNS ON 13 MICHIGAN FARMS 1936-1937

H. B. TAYLOR
SECTION OF FARM MANAGEMENT

Thirteen steer feeders cooperated with the Farm Management and Animal Husbandry departments in the keeping of complete cost records on their 1936-'37 feeding operations. Records were kept by seven farmers in Lenawee County, four in Calhoun, and one each in Washtenaw, and Clinton counties.

The number of feeder steers and heifers on those farms totaled 486 head, ranging from 7 on one farm to 109 on another, and averaging 37 per farm (Table 1). Six of the steers died while on the farms. All of the cattle were steers except for one lot of 41 heifers. (In this article the heifers and steers are all included under the heading of steers.)

Most of the cattle were Herefords, although there were some Shorthorns. The purchase dates averaged Nov. 23, 1936 and the sale dates averaged June 1, 1937. The steers were on feed an average of 190 days, although one lot was fed 100 days and another 259 days. The steers weighed an average of 592 pounds at the market when bought and 923 pounds at the market when sold. Thus, the net gain based on market weights averaged 331 pounds, or 1.74 pounds daily per steer. Purchase price including delivery costs averaged $7.42 per 100 pounds. Sale price averaged $11.53, thus there was a gross margin of $4.11 per hundred pounds.

The cost of the feeders represented 48 per cent of the total cost of the finished steers, while feed accounted for 43 per cent and other costs 9 per cent. The profit per steer averaged $23.15 but ranged from $63.46 profit on one lot to $18.26 loss on another.

To produce 100 pounds of net gain on the steers (based on market to market weights) those farmers fed an average of 572 pounds of concentrates, and 1,343 pounds of roughages. Feed cost per 100 pounds of net gain averaged $12.05 or 83 per cent of the total cost of $14.50 for producing a hundred pounds net gain on the steers. Thus, the 592 pounds starting weight of the steer cost $7.42 a hundred and the finished steer at 923 pounds cost $9.96 per hundred. After considering all costs and all credits there was a return of $1.59 for every dollar of feed fed.

High and Low-cost Feeders—The five steer feeders having the lowest cost per 100 pounds of gain had an average return of $1.97 for each dollar of feed fed (Table 1). That is evidence that they were more efficient feeders than the five high-cost feeders who averaged $1.25 for each dollar of feed fed.

To produce 100 pounds of gain, the low-cost group fed 322 pounds of concentrates while the high-cost group fed 1,044 pounds. Since there was such a large difference in the amounts of concentrates fed per 100 pounds of gain, it might be well to explain that there was also a relatively large difference in the roughages fed. The difference in roughages, however, was not in total amounts fed (see Table 1), but in the proportions of the different kinds. For instance, 80 per cent of the roughages fed by the low-cost feeders was corn silage. The remaining 20 per cent was hay. On the other hand, the roughages fed by the high-cost feeders consisted of silage, 20 per cent; hay, 45 per cent;

Table 1. Beef feeding costs and returns on 13 Michigan Farms, 1936-37.

Item	Average Results for:		
	All Farms	Low-cost Five Farms*	High-cost Five Farms*
Number of steers at start (per farm)	37	35	21
Death loss (per cent)	1	0	0.9
Purchase date	11/23/36	11/20/36	1/2/37
Days on feed	190	211	198
Purchase price per cwt. (at farm)	$7.42	$7.16	$8.15
Gross margin	4.11	4.12	5.63
Concentrate cost per cwt	1.50	1.60	1.57
RETURN PER DOLLAR FEED FED	1.59	1.97	1.25
PER FINISHED STEER:			
Steer weight at start (lbs.)	592	435	674
Net gain (market weights) (lbs.)	331	409	327
Daily gain (market weights) (lbs.)	1.74	1.94	1.65
Pork produced (lbs.)	32	49	51
Concentrates fed (lbs.)	1,894	1,317	3,417
**Roughages fed (lbs.)	4,448	4,976	4,091
Man labor (hrs.)	8.2	8.1	14.0
CHARGES:			
Steer cost	$43.92	$31.12	$54.88
Feed	39.89	34.72	64.35
Labor (at 25 cents an hour)	2.10	2.02	3.50
Use of buildings and equipment	1.71	1.46	3.44
Interest on steer cost	1.27	.97	1.70
Other charges	3.04	2.57	6.27
Total	$91.93	$72.86	$134.14
CREDITS:			
Steer	$106.59	$95.15	$138.68
Pork produced	3.55	5.58	5.88
Manure	4.94	5.82	5.61
Total	$115.08	$106.55	$150.17
PROFIT	23.15	33.69	16.03
PER 100 POUNDS NET GAIN:			
Concentrates fed (lbs.)	572	322	1,044
**Roughages fed (lbs.)	1,343	1,217	1,250
Feed cost	$12.05	$8.49	$19.66
Total cost	14.50	10.21	24.22
Total credits	21.49	18.44	29.12
PROFIT	6.99	8.23	4.90

*Based on cost per 100 pounds of net gain.
**Excluding pasture.

and corn stover, 35 per cent. Thus, the roughages fed may have had some influence on the amounts of concentrates fed.

The five low-cost feeders bought cattle weighing an average of 435 pounds, or 239 pounds less than those bought by the high-cost group. The rate of gain was higher for the lighter cattle. The labor, buildings and equipment charge was less per steer on the low-cost farms largely because there were more steers fed per farm.

Feeding Efficiency—Feed cost made up 83 per cent of the total cost of 100 pounds of gain; thus feeding efficiency was important. The low-cost feeders had a feed cost of $11.00 per 100 pounds of gain compared with $19.20 for the high-cost group. To put 100 pounds of gain on their steers the low-cost feeders fed an average of 401 pounds of concentrates and 1,480 pounds of roughages. On the other hand, the high-cost feeders fed 1,000 pounds of concentrates and 980 pounds of roughages to put on 100 pounds of gain. The high-cost feeders, however, fed steers that weighed 200 pounds a head heavier at the start than those of the low-cost feeders. The profit per steer averaged $25 for the low-cost feeders compared to $19 for the high-cost.

Daily Gain—The five lots of cattle making the fastest daily net gain per steer (1.94 pounds) returned $1.97 for each dollar of feed fed compared to $1.27 returned by the five lots with the least rate of gain (1.53 pounds). The group of steers that made the fastest gains (1) were younger cattle, (2) weighed 235 pounds less per steer at the start, (3) made 140 pounds more net gain per steer, (4) were on feed 50 days longer, and (5) consumed 380 pounds less concentrates per 100 pounds of net gain.

The total cost per 100 pounds of gain for the fast-gaining group was $10 compared to $17 for the slow-gaining group. It is generally recognized that younger cattle make most effective utilization of feed. The main difference between calves and more mature cattle in this regard is the increased maintenance requirements on the part of the older and heavier cattle thus making their gains more costly. The profit per steer was $33.69 for the fast-gaining group or three times greater than that of the slow-gaining group.

Steer Weight When Bought—In this study the four lots of heavy cattle, averaging 782 pounds at the start, consumed more than three times as much concentrates, but only three-fourths as much roughages per 100 pounds net gain as the four lots of light cattle, averaging 412 pounds. The cost of feed for 100 pounds net gain for the heavy cattle was $18.36, or more than double that for the light cattle. On the other hand, largely because of higher margin and greater steer weight, the heavy cattle returned $3.88 higher profit per 100 pounds of net gain than the light cattle.

Days on Feed—The number of days the steers are on feed is closely associated with their condition and weight when purchased. In this study the steers averaged 190 days on feed. There were five lots of short fed steers that averaged 128 days on feed. Those steers being older and heavier, made slightly less daily gain per steer than the five lots of long-fed steers averaging 236 days on feed. The return per dollar of feed fed was practically the same for both groups. Feed cost

Table 2. Beef feeding costs and returns in Michiga

Item	Average Results for:		
	1932-'33	1933-'34	1936-'37
Number of farms	12	15	13
Number of steers per farm	47	51	37
Death loss (per cent)	1.8	1.8	1.0
Purchase date	11/15/32	12/30/33	11/23/36
Days on feed	312	232	187
Purchase price per cwt	$6.19	$5.39	$7.42
Gross margin per cwt	.32	2.22	4.11
Concentrate cost per cwt	.78	1.16	1.50
RETURN PER DOLLAR FEED FED	1.04	1.22	1.59
PER FINISHED STEER:			
Weight at start (lbs.)	436	513	592
Net gain (lbs.)	549	467	331
Daily gain (lbs.)	1.76	2.01	1.74
Concentrates fed (lbs.)	3,750	2,690	1,894
Roughage fed (lbs.)	2,510	2,509	4,448
Man labor (hrs.)	10.0	6.5	8.2
CHARGES:			
Steer cost	$28.57	$28.16	$43.92
Feed	34.36	39.76	39.89
Other	7.49	5.70	8.12
Total	$70.42	$73.62	$91.93
CREDITS:			
Steer	$60.37	$74.62	$106.59
Pork and manure	11.39	7.93	8.49
Total	$71.76	$82.55	$115.08
PROFIT	1.34	8.93	23.15
PER 100 POUNDS NET GAIN:			
Concentrates fed (lbs.)	693	587	572
Hay fed (lbs.)	261	182	285
Silage fed (lbs.)	203	366	964
Other roughages fed (lbs.)	—	—	94
Feed cost	$6.35	$8.67	$12.05
Total cost	7.74	9.91	14.50
Steer credits	5.88	10.14	18.93
Total credits	7.99	11.87	21.49
PROFIT	.25	1.96	6.99

per 100 pounds of gain, however, was $13.27 for the short-fed group compared to $11.14 for the long-fed. The profit per steer was $17.72 for the short-fed cattle, or about one-half as much as for the long-fed cattle.

Margin—In this study, the margin ranged from $2.50 a hundred for one lot of steers to $8.01 for another and averaged $4.11 for all lots. The feeders having the widest margins had higher than average costs per 100 pounds of gain due to heavier steers. Despite higher costs, however, the profit per steer for the wide margin group was $43.89, or about three times greater than for the narrow margin group. Thus, the prices paid for feeding steers and the sale price had a greater influence upon profits than any other factors. For this reason, the successful feeder studies carefully the type of cattle which are going to be in greatest demand at the season he expects to sell and also endeavors to anticipate business conditions.

A COMPARATIVE STUDY OF THE VALUE OF ALFALFA AND A MIXTURE OF ALFALFA AND SMOOTH BROME GRASS AS A PASTURE FOR DAIRY CATTLE

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SECTIONS OF FARM CROPS, FARM MANAGEMENT AND DAIRY

The native pastures of the state of Michigan are largely made up of either Kentucky or Canadian bluegrass or a mixture of both. As a general rule these pastures are productive for a period of about six weeks after which they become dormant, the forage dries up and even though considerable dried grass is still present on the pasture, it is neither palatable nor nutritious. This is particularly true of those pastures used for dairy cattle. The production of milk on these pastures in any quantity is usually confined to about a six-week period, up until June 15, after which production declines rapidly. As a result, either barn feeding must be resorted to in order to keep up the milk flow, or pastures must be provided which contain more drouth-resistant plants that persist and produce palatable and nutritious forage during the hotter and drier part of the summer. This period of hot, dry weather in Michigan is generally confined to the period from June 15 to September 1.

Owing to the failure of June grass as a season-long pasture many dairymen have been using alfalfa as a summer pasture and more recently have started to use a mixture of alfalfa and smooth bromegrass. Both alfalfa and smooth bromegrass are drouth-resistant, palatable and nutritious when native pastures are dry and dormant.

In an attempt to find the value of alfalfa or a mixture of alfalfa and smooth bromegrass for pasture, an experiment was set up at the W. K. Kellogg Farm, a sub-station of the Michigan Agricultural Experiment Station, and located near Augusta, Mich. The experiment was set up in duplicate two-acre paddocks. The soil, which is a Fox sandy loam, was limed with seven yards of marl per acre in 1929 and was fertilized with 300 pounds of 0-8-24 per acre in 1934. The spring seeding of the paddocks failed so the land was refitted and sown again in August 1935, without a nurse crop. The alfalfa was of the Hardigan variety and was seeded at the rate of 10 pounds an acre. The mixture of alfalfa and smooth bromegrass consisted of 8 pounds of Hardigan and 7 pounds of bromegrass. The cows for the grazing test were selected by a member of the dairy department, cows being selected with a view to getting individuals with approximately equal production records and in the same period of lactation, on each paddock. Grazing was started on the paddocks on May 27, 1936. The seasonal grazing on each two-acre paddock was as follows: 3 cows May 27-July 8; 2 cows, July 9-18 inclusive; no grazing July 19-September 29; 2 cows September 30-October 24. The summer months of June, July

and August, 1936, were excessively dry, only 2.13 inches of rain were recorded between June 2 and August 18, which accounts in part for the low returns from the pasture.

The amounts of grain and silage fed to each cow were recorded, as were the milk test and weights, while the cows were on the pasture. The cows were weighed three times on three consecutive dates previous to turning on pasture and every two weeks thereafter in order to note changes in weight.

The same set-up was used in 1937 and the seasonal grazing on each two-acre paddock was as follows: 3 cows, May 18-24; 4 cows, May 24-June 30; 3 cows, June 30-August 31. During the 1937 pasture season 10.67 inches of rainfall between June 2 and August 18 in contrast to 2.13 in 1936. A cow died of blood poisoning July 30 in the alfalfa paddock No. 2 and was not replaced.

The cost figures for 1936 and 1937 were compiled and the value of the products while the cows were on pasture was calculated. The cost studies are shown in Tables 1 and 2. The pasture was supplemented with a grain mixture made up of 100 pounds oats, 100 pounds corn and 20 pounds of cottonseed meal. In 1936, this mixture was worth $1.60 per 100 pounds and in 1937, $1.83 per 100 pounds. The cows were fed corn silage figured at $3.50 per ton in 1936 and alfalfa silage figured at $4.40 per ton in 1937.

A study of Table 1 shows that even in the dry summer of 1936 with a shortage of rainfall and on a young seeding, the net acre return of a bromegrass and alfalfa mixture was $11.92 per acre on a cream basis after grain and silage, labor and other charges and the estimated cost of producing the pasture were charged against the pasture. The straight alfalfa returned $7.87 net per acre or a decrease of $4.05 per

Table 1. The net return per acre from dairy cows pasturing on duplicate two-acre paddocks of alfalfa and alfalfa-bromegrass mixture during the pasture season of 1936.

Items	Alfalfa-brome			Alfalfa		
	Paddock I	Paddock II	Per Acre Average	Paddock I	Paddock II	Per Acre Average
Milk production in pounds	7,099	6,259	3,340	6,314	6,045	3,090
Butterfat production in pounds	302.3	287.8	148	279.8	279.9	140
Value of milk at $2.32 per cwt	$164.70	$145.21	$77.48	$146.49	$140.24	$71.70
Value on cream basis (butterfat at 32-1/3 cents per lb., skim milk at 20 cents per cwt.)	109.80	103.68	53.53	101.19	100.77	50.51
Concentrates fed (lbs.)	1,612	1,699	828	1,890	1,677	892
Corn silage fed (lbs.)	1,140	1,140	570	1,140	1,140	570
Pasture days	197	197	99	197	197	99
Value of concentrates and silage	$27.79	$29.18	$14.24	$32.24	$28.83	$15.27
Labor and other charges	34.74	34.74	17.37	34.74	34.74	17.37
Total cost except pasture	$62.53	$63.92	$31.61	$66.98	$63.57	$32.64
Return for pasture and management of cows on milk basis	102.17	81.29	45.87	79.51	76.67	39.04
Return for pasture and management of cows on cream basis	47.27	39.76	21.92	34.21	37.20	17.87
Estimated pasture cost	20.00	20.00	10.00	20.00	20.00	10.00
Profit on pasture and cows (milk basis)	82.17	61.29	35.87	59.51	56.67	29.04
Profit on pasture and cows (cream basis)	27.27	19.76	11.92	14.21	17.20	7.87
Net T.D.N. per acre from pasture	—	—	1,144	—	—	1,022

acre when compared to the alfalfa and bromegrass mixture. When the value of the pasture was figured on a milk basis of $2.32 per hundred, which was a special market price received for the Kellogg farm milk, the pastures returned $35.87 and $29.04 an acre net, respectively. The pastures during this season furnished only 99 cow days per acre.

However, in 1937 (Table 2) it will be noted that the mixture furnished 175 days pasture and the alfalfa 168 days. Both pastures were grazed at the rate of a cow and a half per acre from May 18 until September 1 with an extra cow on each two-acre paddock from May 24 until June 30. The pastures were never grazed closer than 6-8 inches from the ground and under this system of management, it was possible to keep the plants healthy and productive. During September, the cows were pastured elsewhere because it is during this month that the alfalfa plants are storing reserve food in their roots to last them over winter and to initiate new growth the following spring. When the top growth is closely grazed off during September the plants have little chance of storing these reserves before freezing weather sets in. It is possible to use native pastures during September, hay fields which are to be plowed up, or graze the total acreage of alfalfa in such a way as to have three or four acres available for each cow.

Table 2. The net return per acre from dairy cows pasturing on duplicate two-acre paddocks of alfalfa and alfalfa-bromegrass mixture during the pasture season of 1937.

Items	Alfalfa-brome			Alfalfa		
	Paddock I	Paddock II	Per Acre Average	Paddock I	Paddock II	Per Acre Average
Milk production in pounds	8,830	8,544	4,346	10,040	8,614	4,664
Butterfat production in pounds	408.2	400.6	202	458.3	417.2	219
Value of milk at $2.90 per cwt	$256.33	$247.78	$126.02	$291.16	$249.81	$135.24
Value on cream basis (butterfat at 32-1/2 cents per lb., skim milk at 25 cents per cwt.)	151.44	148.35	74.89	170.30	153.90	81.09
Concentrates fed (lbs.)	1,152	936	522	1,512	1,728	810
Alfalfa silage	3,720	3,720	1,860	3,720	3,080	1,700
Pasture days	350	350	175	350	320	168
Value of concentrates and silage	$29.26	$25.31	$13.70	$35.85	$38.40	$18.56
Labor and other charges	59.58	59.58	29.79	56.96	56.96	28.48
Total cost except pasture	$88.84	$84.89	$43.49	$92.81	$95.36	$47.04
Return for pasture and management of cows on milk basis	167.49	162.89	182.53	198.35	154.45	88.20
Return for pasture and management of cows on cream basis	62.60	63.46	31.40	77.49	58.54	34.05
Estimated pasture cost	20.00	20.00	10.00	20.00	20.00	10.00
Profit on pasture and cows (milk basis)	147.49	142.34	72.46	178.35	134.45	78.20
Profit on pasture and cows (cream basis)	42.60	43.46	21.40	57.49	38.54	24.05
Net T.D.N. per acre from pasture	—	—	2,008	—	—	1,865

In 1937 the milk was sold at $2.90 per hundred on a special market and the alfalfa-bromegrass mixture returned $72.46 net per acre, the alfalfa $78.20. This return in favor of the alfalfa pasture was largely caused by having one exceptionally good producing cow on the alfalfa. This same cow was on the mixture during 1936. When figured on a cream basis the net acre return was $21.40 and $24.05, respectively. These figures show that it is possible to use good dairy cows on good

pastures and get a profitable return per acre, which is not true when such cows are pastured on June grass. Regardless of fertilizer or management practices on bluegrass pastures in Michigan, it is difficult if not impossible to stretch the profitable pasture season beyond June 15 in an ordinary year, while on good alfalfa or a mixture of alfalfa and smooth bromegrass, it is possible to pasture dairy cows profitably throughout the summer.

RED GRAVENSTEIN

New Apple Variety Recommended for Trial Planting in Michigan

WALTER TOENJES
Section of Horticulture

The advisability of planting any variety of fruit in a given locality depends upon many factors, such as the variety's adaptability to soil and climate, its productivity, quality and appearance, season of maturity, shipping and storage qualities, and the uses to which it may be put. Many of the varieties formerly grown in quantity have lost favor and are being replaced by more profitable sorts. These include some of the newer varieties, and likewise now and then an older one that for one reason or another has never attained prominence. One of these under test at the Graham Experiment Station near Grand Rapids is the Red Gravenstein. The parent variety, Gravenstein, is one of the oldest of well recognized commercial varieties, though its red sports are of more recent introduction.

The Red Gravenstein described here was obtained from the New York Fruit Testing Association as a red sport of the Gravenstein variety which originally came from Germany. It differs from the parent variety only in having attractive, bright, almost solid red-colored fruits in place of the rather sparingly red-striped and splashed normal form. As grown at this station the red coloring frequently shows darker and lighter areas which give the fruit a faint mottled color effect, but which improves rather than detracts from its appearance.

In shape the fruit is roundish oblate and slightly angular in outline. It is medium to large in size, comparing favorably in this respect with such varieties as Baldwin and Northern Spy as they are grown in Michigan. The flesh is nearly white, firm, tender, crisp, juicy, and mildly acid. The quality is excellent either for dessert or cooking purposes. The rather thick skin and firm flesh would permit it to be shipped successfully if properly handled and packed. The variety matures with Wealthy, at a season when a high quality dessert and cooking apple would be favorably received by the consumer.

Fortunately the variety can be successfully held in storage for a considerable time. Fruits placed in common air-cooled storage at the time of harvest were in good condition the latter part of the following January, while those placed in cold storage were in excellent condition at that time. Commercially it would probably be undesirable to attempt to hold this variety in storage for long periods, but ability to keep in storage is a valuable characteristic in any variety.

The character of the tree also has much to commend it. It is hardy, a strong vigorous grower, with a roundish, moderately open top. The crotches are strong, with the fruiting branches rather stocky in nature, indicating a tree capable of carrying heavy crops without serious injury from splitting or breaking. It is productive. Neither the foliage nor the fruit have shown any marked susceptibility to apple scab or spray burn. No fire-blight infections have been evident on this variety during the testing period, although susceptible trees nearby were infected by the blight organism.

Fruit growers desiring to grow a high quality dessert and cooking apple, either for a special trade, roadside market or for shipment, one that matures at the season of the year when few good cooking or eating apples are available, are advised to consider this variety as a possible addition to include in their fruit growing program.

CONVENIENT HOME GERMINATOR

H. R. PETTIGROVE
Section of Farm Crops

Every person who plants seeds is interested in the germination of those seeds. It is imperative they grow. The project, whether it be a garden or a farm, represents an investment in land, labor and money and there is no return until a harvest is made.

Commercial germinators are too expensive for individual use and the rag doll, as generally described, requires considerable attention. The sand and sawdust boxes are good but space and material are often a handicap.

Home germinative tests can be made with confidence and accuracy by using the "Milk Can Germinator". The method is similar to the rag doll but requires no attention during the process of germination.

A 10-gallon milk or cream can is the germinator. The opening at the top must be equal to or greater than one-half the diameter of the milk can. A hole 3/16th of an inch in diameter is drilled through the side of the milk can three inches from the bottom (inside measurement).

A germinative rack is a necessary part of the equipment. From a board, cut two half-circles which, together, form a diameter about one inch less than the diameter of the milk can. Several one-inch holes are bored through each of the boards to permit free circulation of the air. The rack is completed by nailing, with one nail each, two 3½-inch legs to each board. One leg is attached to the board at the center of

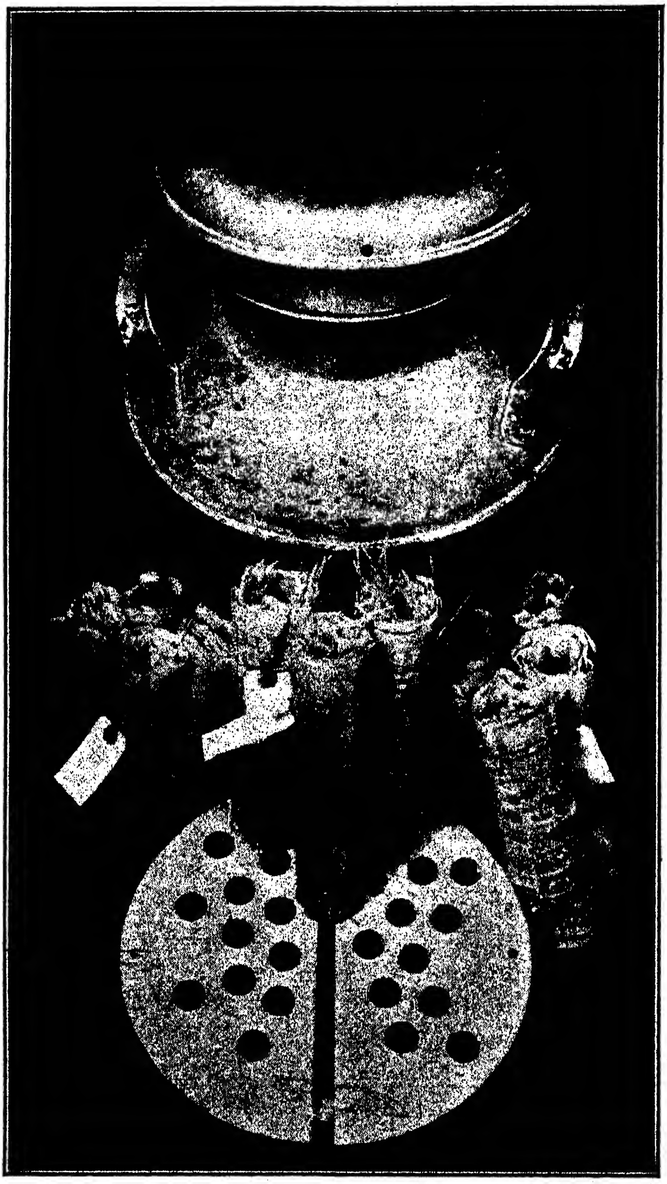

Fig. 1. The "Milk Can Germinator," rack and dolls.
Note the growth of the plants.

the circumference and the other is attached to the board on the straight side about two inches in from the outside edge. The leg, on the straight side, is attached so as to permit the other board to rest upon it. Place the rack in the milk can, add water to within one inch of the rack and the germinator is ready.

A germinative doll is next made. Open two sheets of a newspaper and fold them together lengthwise. Thoroughly wet the paper and lay out on a flat surface.

Count the seeds to be germinated and scatter them over the paper leaving a six-inch border at each end. Damage, resulting from moldy seeds, is kept at a minimum by carefully spacing those seeds which are touching.

Fig. 2. Interior of the germinator, showing the position of the dolls on the rack.

Roll a piece of paper into a core about 1 or 1½ inches in diameter. Dip the core into a bucket of water and place it on one end of the paper. Roll the sheets of paper loosely about the core, using enough pressure to hold the seeds in place.

When the doll is rolled up, tie each end loosely with a string or use rubber bands. Label, submerge in water and place it in the germinator. After all the dolls are in the germinator and the cover fitted, they need no further attention until they are removed and read. The paper will remain sufficiently moist for the growth of the plants.

Keep the milk cans in a room with a temperature of 70-75 degrees F. and do not permit the temperature to go too low at night. Several

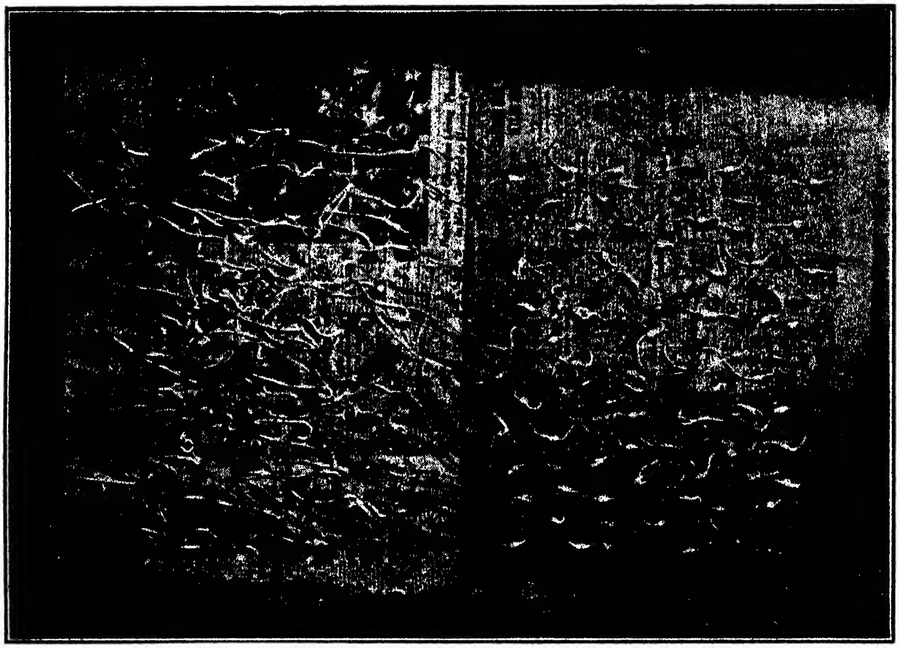

Fig. 3. Quick germination makes the corn test easy to read. The test on the left germinated in six days in a milk can with ventilation. The test on the right germinated in six days in a milk can without ventilation. The growth (on the right) is very poor and the seeds are discolored.

dolls placed in the germinator at one time give a little faster germination than do one or two. The germinating seeds generate heat which increases the rate of growth.

Five to seven days will be required for the growth to become large enough to read. Remove the doll, carefully unroll and read the germination. The dead seeds are usually moldy. The weak seeds will produce a shorter and less thrifty plant than the strong seeds. This method of germination is very satisfactory because the mold does not spread from one seed to the other through the paper.

A "Milk Can Germinator" may be used for any seed, no matter how large or how small, except for beet seed. Beet seed apparently cannot take up sufficient moisture for quick germination and may rot before it sprouts.

A milk can may be used without drilling a hole near the bottom, but it will be necessary to remove the cover once or twice daily and create a change of air by moving a paper briskly back and forth across the top of the can.

When the milk can is sealed tight, the seeds germinate very poorly or not at all. Thus, the small hole near the bottom of the milk can permits the carbon dioxide to escape and be replaced by air containing oxygen.

The "Milk Can Germinator" is a simple method to obtain an accurate germinative test of seeds. Be sure and sterilize the can and rack with boiling water after they have been used once or twice.

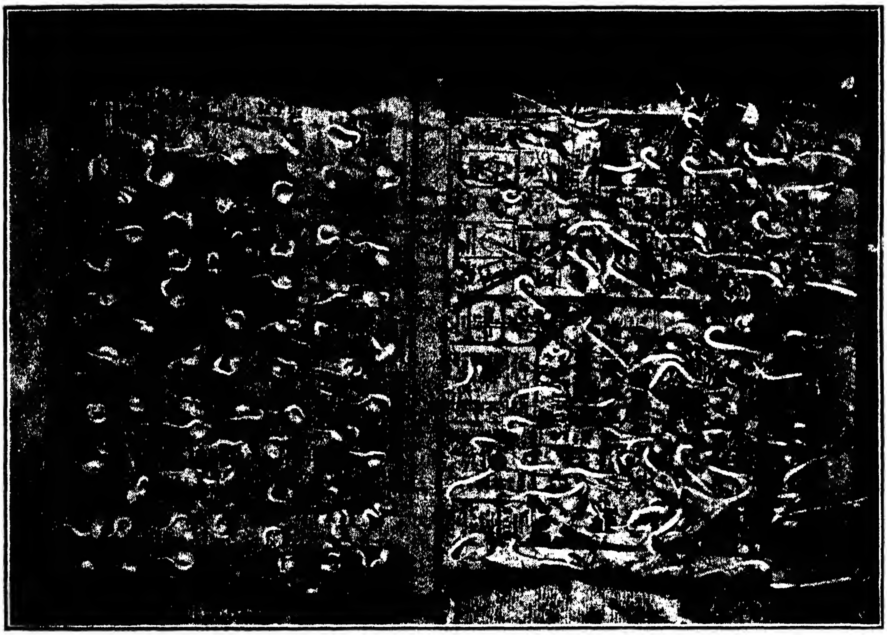

Fig. 4. Beans respond to ventilation. Note the vigorous growth on the right and the poor, weak growth on the left after six days in the germinator. The seed coats show considerable discoloration when there is no ventilation.

COMPARATIVE COST OF BANK AND PRODUCTION CREDIT ASSOCIATION CREDIT

R. J. BURROUGHS AND F. A. VOSS
SECTION OF ECONOMICS

Since the establishment of production credit associations[1] Michigan farmers have been called upon to choose between this cooperative credit system and the facilities of the local banks. Both types of institution lend money for operating capital such as seed purchases or labor costs and for feeder, dairy or breeder stock, machinery, etc. Such loans can be repaid either from the income available at the end of a crop year or following sale of fattened stock; from income made available by

[1]June 16, 1933, c. 98, Sec. 2, 48 Stat. 257.

employment of machinery or income producing livestock, or from any other source of funds.

The farmer's choice of lender may be determined by his personal attitude toward cooperatives or private business. He may be influenced by considerations of service, speed, "red-tape" or lack of it, or by the personality of the lender. The borrower may remember that the associations have been willing lenders in depression, while banks have been forced to restrict loans at such periods. Certainly the farmer should be influenced by the comparative cost of obtaining credit.

This article compares the cost of bank and PCA credit for a number of cases and shows how the cost can be calculated by the farmer himself.

The replies of 110 banks to a questionnaire sent under the auspices of the Michigan Bankers Association[2] to 380 banks indicate that most banks charge 6 or 7 per cent with a 50 cent minimum loan fee. Replies to the question "What rates of interest do you charge for customers' loans?" are distributed as follows:

Rate	Number of Banks
6 per cent discount	1
6 per cent interest	25
7 per cent interest	39
6 and 7 per cent interest	38
5 to 7 per cent interest	3
7 to 10 per cent interest	1
Unknown	3
Total	110

Replies to the question "Under what circumstances do you charge minimum loan fees, and how much?" are distributed as follows:

Fee	Number of Banks
None	8
25 cent minimum	2
50 cent minimum	60
65 cent minimum	2
75 cent minimum	1
$1.00 minimum	8
1.50 minimum	1
50 cents interest	6
50 cents for renewals	1
Chattel mortgage inspection $1.50	1
Investigation and drawing paper	1
10 per cent discount on loans of $100 or less	2
$5.00 to $10.00 service fee on auto installment paper	1
Unknown (mostly some charge but terms uncertain)	18

[2]See Burroughs and Frisbie, "Short-term Loans to Michigan Country Banks," Mich. Agr. Exp. Sta. Quar. Bul., Vol. 20, No. 2, November, 1937.

Another question asked the bankers was "Do you generally require endorsement or other security on loans to farmers? If so, what form of security?" The answers are:

Answers		Number of Cases
No		30
Yes		75
Chattel mortgage	67	
Endorsement	22	
Real estate mortgage	5	
Unknown		5
Total		110

Obviously both a chattel mortgage and endorsement are required in many cases. Detailed study of several banks[3] indicates less use of the chattel mortgage than answers to the questionnaire would suggest. In some cases, however, what is known as a property note is freely used. This form of security is essentially an unrecorded chattel mortgage.

In this paper, as a basis for comparison it is assumed that the banks charge either 6 or 7 per cent interest with a 50 cent minimum. It is also assumed that each loan is secured by a recorded chattel mortgage for which there is a uniform 25 cent charge in Michigan by each register of deeds. This charge is on a per item basis without reference to the size of the loan.

The basic interest rate of production credit associations is now 5 per cent. In addition, there are inspection fees, which vary with the size of the loan.[4] Subject to $2.50 minimum, the inspection fee is $1.00 per $100 for the first $400, 50 cents per $100 for the $400 to $800 bracket, and 25 cents per $100 for the portion of the loan in the amount of $800 or more, with an $8.00 maximum charge. A loan of $2,000 or more requires the maximum fee.

"In the case of renewals the usual plan is to charge only the actual cost of the inspection if that happens to be less than the legal fee. This sometimes results in a somewhat lower rate on renewals."[5] In practice, few notes exceed 12 months although the upper limit is three years established by the maturities eligible for rediscount with the Federal Intermediate Credit Banks which provide the PCA with loanable funds.

Finally, the 25-cent filing fee is charged by the register of deeds

[3]Ibid.

[4]PCA Bul. No. 174, April 6, 1937.

[5]Letters dated January 24, 1938, to the senior author, by Wm. L. Cavert, Statistician for Farm Credit Administration of St. Paul. In a letter of April 13, Mr. Cavert says, "In case of renewals, a number of production credit associations are making an inspection fee for renewals of $2.50 regardless of the size of the loan". Furthermore, "In a few cases where the loan has been paid down to a fraction of the original amount, a renewal is made without an inspection fee". Where there is abstracting to be done the PCA often does that for much less than county officers. The charge "is seldom over $1.50".

for each chattel mortgage recorded. This fee is said to be absorbed by the PCA in some communities, but in such cases the difference in the resultant cost is a minor one.

An important consideration to the farm borrower is the fact that the PCA is strictly cooperative. The institution lends only to stockholders. If a prospective borrower is not a stockholder, he is permitted to become one by a deduction from his loan. The par value of his stock must never be less than 5 per cent of his outstanding obligations to the PCA. Some may regard this requirement for stock ownership as an additional cost, especially if a PCA were to become insolvent. On the contrary, stock ownership may be regarded as an investment which ultimately may earn cash dividends, and which always will serve as an entre to a willing lending institution even at times when banks are forced to restrict their loans in order to meet their deposit obligations. For purposes of this paper the stock investment is not regarded as a cost.

The relationship of the amount paid for the use of the money to the amount borrowed determines the cost of credit. Since interest is figured on a yearly basis, all charges must be reduced to the annual basis for comparison. The accompanying table compares the cost of credit from production credit associations with that of Michigan country banks. Since PCA notes receivable rarely exceed a 12 month maturity the PCA costs are given both with and without renewal fees for loans exceeding 12 months. In each instance the figures include the basic interest rate of 5 per cent, the basic inspection fee, and the filing charge. The bank costs are given both for 6 and 7 per cent interest rates but are subject to the minimum loan fee and include the 25 cent filing charge.

Obviously, the cost of borrowing in small amounts for a short time is expensive, and rightly so in view of the costs of providing small loans. Furthermore, the short-term loans are more costly than long-term loans regardless of the size of the loan. A careful study was made of 18-, 12-, and 6-month maturities to determine the breaking point wherein one lender provides credit more cheaply than the other. If the loan is for one year, no renewal fees being charged, and the bank charges 7 per cent interest, credit is less costly from the bank provided the amount borrowed is less than $125.[6] However, if the amount borrowed exceeds $125, credit from the PCA is less expensive to the borrower. On the other hand, if the bank charges only 6 per cent interest, any amount of less than $300 can be procured more cheaply from the bank. Between $300 and $400 the difference is negligible. Above $400 the advantage is in favor of the PCA.

In the case funds are borrowed for 18 months, again assuming no renewal fees and 7 per cent bank interest, loans under $165 may be procured more cheaply from the bank. Above this amount PCA credit is cheaper. The breaking point for a 6 per cent bank rate is about $453.

Six-month loans definitely favor the bank. If the bank rate is 7 per cent, loans must exceed $400 to be significantly cheaper from the PCA. Between $300 and $400 the difference is negligible. If the bank charges

[6]The breaking points here are given within a dollar or two either way of accuracy, having been derived by graphical interpolation.

Comparative Cost of Credit from Production Credit Associations and from Representative Michigan Banks.

Amount of Loan	Number of Months	Production Credit Association		Michigan Banks	
		Actual Rate per Annum when Interest Rate=5%	Actual Rate per Annum Exclusive of Renewal Fee*	Actual Rate per Annum when Interest Rate=6%	Actual Rate per Annum when Interest Rate=7%
		Per Cent	Per Cent	Per Cent	Per Cent
$10	1	....	....	90.00	90.00
	2	....	....	45.00	45.00
	3	....	....	30.00	30.00
25	1	....	....	36.00	36.00
	2	....	....	18.00	18.00
	3	....	....	12.00	12.00
50	1	70.80	....	18.00	18.00
	2	37.92	....	9.00	10.01
	3	26.96	....	8.00	9.01
	6	16.00	....	7.00	8.01
75	1	48.96	....	12.00	12.00
	2	26.94	....	7.98	9.01
	3	19.68	....	7.32	8.34
	6	12.34	....	6.67	7.68
100	2	21.48	....	7.50	8.50
	3	16.00	....	7.00	8.00
	6	10.50	....	6.50	7.50
	12	7.75	....	6.25	7.25
150	3	12.36	....	6.68	7.67
	6	8.66	....	6.34	7.33
	12	6.83	....	6.17	7.17
	18	7.33	6.22	6.11	7.11
	24	6.75	5.91	6.08	7.08
200	6	7.76	....	6.25	7.25
	12	6.38	....	6.12	7.12
	18	6.75	5.92	6.08	7.08
	24	6.31	5.69	6.06	7.06
250	6	7.60	....	6.20	7.20
	12	6.30	....	6.10	7.10
	18	6.53	5.87	6.07	7.07
	24	6.15	5.65	6.05	7.05
300	6	7.16	....	6.16	7.16
	12	6.08	....	6.08	7.08
	18	6.28	5.72	6.05	7.05
	24	5.96	5.59	6.04	7.04
400	6	7.12	....	6.12	7.12
	12	6.06	....	6.06	7.06
	18	6.13	5.71	6.04	7.04
	24	5.89	5.58	6.03	7.03
500	6	6.90	....	6.10	7.10
	12	5.93	....	6.05	7.05
	18	5.95	5.63	6.03	7.03
	24	5.72	5.47	6.02	7.02
650	6	6.76	....	6.08	7.08
	12	5.88	....	6.04	7.04
	18	5.85	5.59	6.03	7.03
	24	5.68	5.44	6.02	7.02
	36	5.55	5.29	6.01	7.01

Comparative Cost of Credit from Production Credit Associations and from Representative Michigan Banks—Continued.

Amount of Loan	Number of Months	Production Credit Association: Actual Rate per Annum when Interest Rate=5%	Production Credit Association: Actual Rate per Annum Exclusive of Renewal Fee*	Michigan Banks: Actual Rate per Annum when Interest Rate=6%	Michigan Banks: Actual Rate per Annum when Interest Rate=7%
		Per Cent	Per Cent	Per Cent	Per Cent
$800	6	6.56	....	6.06	7.06
	12	5.78	....	6.03	7.03
	18	5.73	5.52	6.02	7.02
	24	5.54	5.39	6.02	7.01
	36	5.47	5.26	6.01	7.01
	48	5.43	5.19	5.99	7.01
1,000	6	6.36	....	6.04	7.04
	12	5.68	....	6.02	7.02
	18	5.61	5.45	6.02	7.02
	24	5.46	5.33	6.01	7.01
	36	5.39	5.23	6.00	7.01
	48	5.37	5.17	6.00	7.00
1,200	6	6.20	....	6.04	7.04
	12	5.60	....	6.02	7.02
	18	5.54	5.40	6.01	7.01
	24	5.40	5.01	6.01	7.01
	36	5.34	5.20	6.01	7.01
	48	5.31	5.15	6.00	7.00
	60	5.29	5.12	6.00	7.00
1,500	6	6.06	....	6.04	7.04
	12	5.53	....	6.02	7.02
	18	5.47	5.35	6.01	7.01
	24	5.35	5.26	6.01	7.01
	36	5.29	5.11	6.01	7.01
	48	5.26	5.13	6.00	7.00
	60	5.24	5.11	6.00	7.00
2,000	6	5.82	....	6.02	7.02
	12	5.41	....	6.01	7.01
	18	5.36	5.27	6.01	7.01
	24	5.27	5.20	6.00	7.00
	36	5.22	5.13	6.00	7.00
	48	5.19	5.10	6.00	7.00
	60	5.18	5.08	6.00	7.00
	72	5.17	5.07	6.00	7.00

*Few notes exceed 12 months, but in the event a note on a longer loan is made for more than 12 months this column of interest cost is applicable.

only 6 per cent, at least $1,565 ± $3 must be borrowed before the PCA is on a competitive basis.

One aspect of this comparison which may be mentioned, is the tendency of banks to insist on short-term notes even though the farmer is borrowing for some purpose which virtually precludes repayment in less than one or two years. Notes of more than a year are rare, while notes drawn for six months or less appear to be the practice.[7] This is in contrast to the PCA's practice of drafting the original note for the

[7]More details concerning this point will be available in a forthcoming bulletin now in preparation. The present information is based on an unpublished manuscript of S. K. Frisbie, to be presented as a master's thesis in economics at Michigan State College.

probable term of indebtedness provided the term does not exceed 12 months. This stuffing of the bank portfolio with short-term notes brings the incidental result of causing a minimum loan charge to be paid for many small loans. For example, amounts of $50 or less for terms of 30 days or so will face a minimum loan fee. A $25 loan running for a year but evidenced by six consecutive 60-day notes would have a 50 cent interest charge each time, or $3.00 for the year. The charge, including one mortgage filing, would probably be $3.50. This is a rate of 14 per cent yearly $\left(\frac{325 \times 100}{25} = 14\%\right)$. The production credit association makes no loans for less than $50, but the two- or three-month loan from the PCA regardless of amount is much more expensive than from a bank, and, if renewed, would continue to cost more.

The method a farmer may use to calculate the cost of credit in a given instance is now apparent. First, calculate the interest on the loan for a given term, thus, 5 per cent of $100 for 60 days is 83 cents (.05 × 100 = $5; divide by fraction of year 60 days represents—$5 ÷ 6 = 83 cents). Add the inspection fee of $2.50 and filing charge of 25 cents, making the total cost $3.58. But this is the expense for only 60 days. At the same rate the charge per year would be six times as much or $21.48; but $21.48 is 21.48 per cent of $100 and therefore the effective rate.

Using another example, a six-month $500 loan may be obtained from PCA at the effective rate of 6.90 per cent. The basic inspection fee is $4.50 and filing fee 25 cents. Interest at 5 per cent is $12.50 (5 per cent of $500 = $25 per year; six months is one-half year or $12.50). The total cost is $17.25 which is 3.45 per cent of $500 $\left(\frac{\$17.25 \times 100}{500} = 3.45\%\right)$. But this is for six months. A similar charge for a year would be twice as much. Hence, the effective rate is 6.90 per cent (2 × 3.45 = 6.90%).

The farmer may have a number of good reasons why he prefers to borrow from one institution rather than from another. Cost of credit is but one consideration. But in every transaction the farmer should know the effective rate he pays. The point of this article is to provide a means whereby the farmer may ascertain the cost.

RETIRED REFRIGERATOR CARS FOR AIR- AND ICE-COOLED STORAGE

A Preliminary Report

H. A. CARDINELL
SECTION OF HORTICULTURE

In 1934 Wright (5) reported that several Indiana growers were using low-cost, retired refrigerator cars for the farm storage of perishables. Impressed with the Indiana experiences, two Michigan fruit growers, L. G. Morrill of St. Clair and Carl Schweikert of Hopkins, purchased such cars in 1937 for summer storage of stone fruits and winter storage of apples.

Description of Cars

The car purchased by Dr. Morrill was a small brine tank car (Fig. 1) designed for service in transporting frozen meat. This car has no floor racks, which investigators in Illinois (2) have shown "caused air movement through the load at that point to be over two and one-

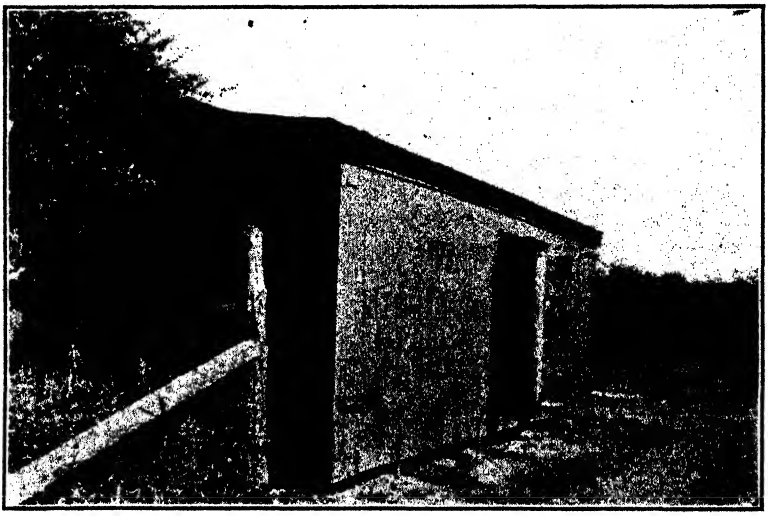

Fig. 1. A brine-tank refrigerator car purchased by L. G. Morrill, St. Clair county, used to precool and hold temporarily some 40 tons of Montmorency cherries.
During the winter the car is used as a fan-circulated air-cooled storage for apples.

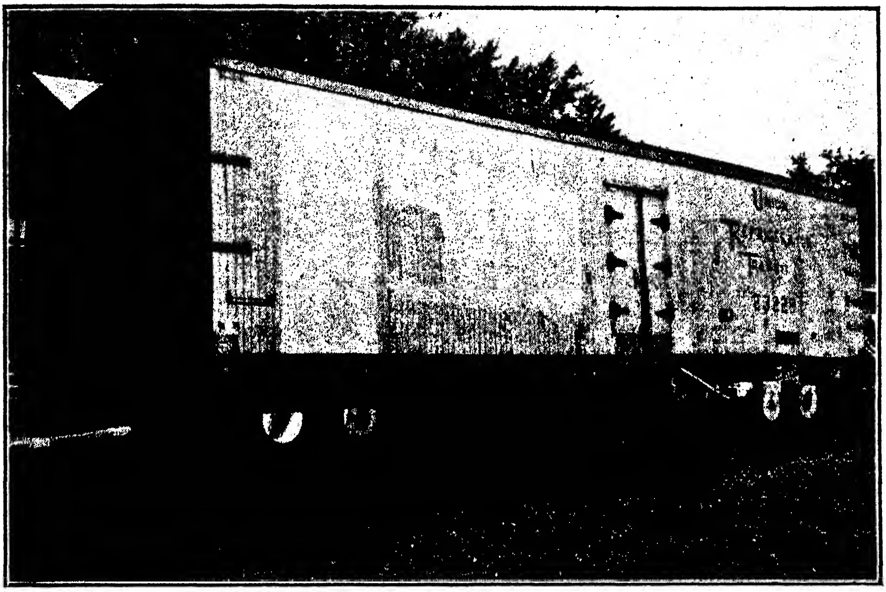

Fig. 2. A view of the refrigerator car purchased by Carl Schweikert of Allegan County. Scrap-iron has been cut away and sold and the 17-ton box is shown resting on three moving trucks on which it was drawn to the orchard. This is a 42-foot car and holds 900 orchard crates.

half times that observed in the car without floor racks". This car has four brine tanks, in either end instead of slatted bunkers used in the common type refrigerator car. Details are not available as to the ordering, cost of removing scrap-iron and moving the car to the orchard. This car was purchased from General American Transportation Corporation, Refrigerator Car Division, Chicago, Ill.

The car purchased by Carl Schweikert was built in 1915, purchased in Milwaukee, Wis., and was set off on a side track at Hopkins, Mich., the nearest point to the orchard. Before ordering the car, Mr. Schweikert arranged with a dealer in scrap-iron to remove all surplus iron not essential for a strong foundation, and to pay the prevailing price for the iron. When the car arrived, Mr. Schweikert telephoned to the iron dealer and the next morning a torch worker was on the job. Using an oxyacetylene torch this man cut away all of the needless iron. This work started at 8:00 a. m. The man who had contracted to move the car to the orchard, jacked-up the car ahead of the cutting torch and by 5:00 p. m. all surplus iron had been removed. As each car truck was cut away, the 20-ton-capacity, wooden-wheeled moving trucks were placed under the car and the next morning it was dragged off the rails and was in the position shown in Fig. 2, ready to be drawn to the orchard. Except for starting the load in motion, which required the assistance of a small truck, a "10-20" tractor with rubber tires hauled the 17-ton car to the farm at a speed of about one mile per hour.

Refrigerator Dimensions

Length:	
Outside	42 ft.
Inside	34 ft. 10-1/8 in.
Width:	
Outside	9 ft. 6 in.
Inside	8 ft. 5-1/8 in.
Height:	
Center	9 ft. 11 in.
Side	9 ft. 2 in.
Doors	48 in. x 73 in.
Capacity	2,178 cu. ft. (900 apple crates) 8,600 lbs. ice
Total weight of car on track	44,700 lbs.
Weight of scrap-iron removed	20,650 lbs.
Net weight of car	24,050 lbs.

Cost Items

Refrigerator car f. o. b. Milwaukee	$175.00*
Transportation to Kalamazoo	(no charge)
Switching and local haul (Kalamazoo-Hopkins)	9.82
Timbers and blocking	6.00
Jacking and moving 1¼ miles, plus labor	42.00
Total	$232.82
Less scrap-iron at $9.00 per ton (20,650 lbs.)	92.93
Net Cost	$139.89

(To this cost must be added the cost of whatever type of foundation is desired. Also a bond must be posted to obtain a permit to move such a structure over the road. Such a permit may be obtained from local road officials on the day it is to be moved.)

Fan Installation

After the car was swept and washed out by means of a spray gun, an electric fan was installed, as suggested by Rose and Gorman, Jr. (4). This was placed in the upper center of the partition or baffle that separates the fruit compartment from the ice bunker. In a brine tank car this is merely a swinging partition hung on metal straps, the top of the partition being about two feet from the ceiling of the car and the bottom coming to within about 1½ feet of the floor. This is so designed that fruit may be stacked against the partition (baffle), yet air may circulate above and beneath the fruit. In this type of car the fan was fastened near the top center of the partition in order to reverse the natural circulation of air. Experiments conducted in California (1) have shown that, "In all cars cooled by reversing the natural circulation, the coldest air is first brought in contact with the warmest fruit and vice versa, so that the entire load reaches a relatively uniform temperature."

In the Schweikert car (a basket-bunker type) a large rotary fan was mounted inside one ice bunker, beneath the cat-walk, and enough of the upper screened partition was cut away to allow the full force of the air to be driven toward the opposite end of the car, as shown in Fig. 4. The fan was mounted on and protected by 2 x 4 inch timbers so that ice could be dropped under and to the side of it. The open-

*The purchase price of these cars varied during 1937 from $125 to $200. Newer and better conditioned cars may be had at slightly higher prices.

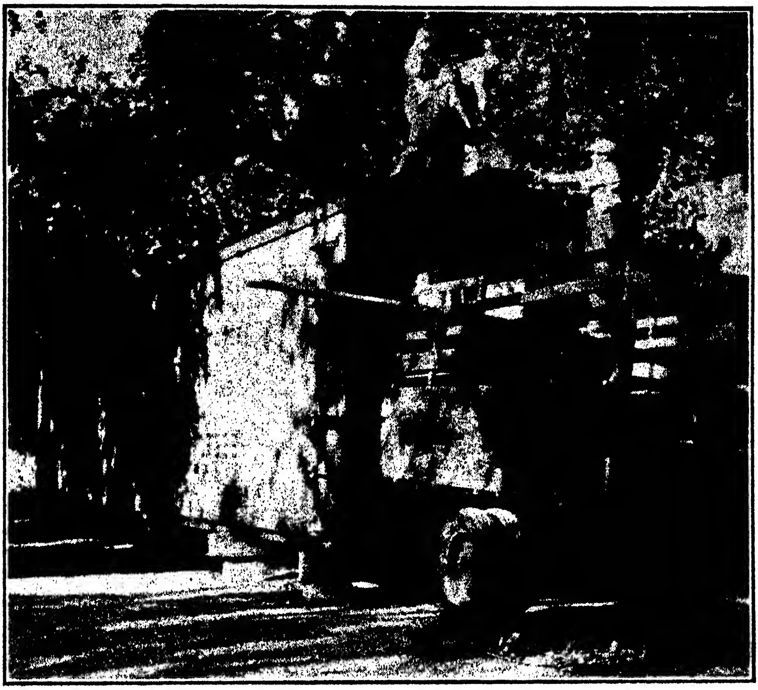

Fig. 3. Mr. Schweikert and his boys are shown putting in the first load of ice to chill the car for the peach harvest last summer. Ice capacity of this car is 8,600 pounds.

ing above the baffle was covered so that all chilled air was drawn through the fan and forced into the room.

Precooling and Storing Cherries

Results—The owner of this car installed an insulated removable partition, in which a narrow door was placed, so that approximately one-half of the car could be chilled with ice and the remainder of the car could be used as a weighing and receiving room or ice could be placed in both bunkers and the entire car chilled when necessary. Morning pickings usually averaged 45°-65° F. of temperature and were placed in the iced end. Afternoon pickings were warmer (75°-90° F.) and, rather than place them under ice at once, they were stacked in the ventilated half of the car and allowed to cool 20°-30° before being placed in the iced section. Studies conducted in California (3) have shown that, "There were differences of as much as 22° in the temperatures of the delivered pears, depending upon the time of day the fruit was picked. After being placed in the packing shed, however, the loose fruit in lug boxes from the field gradually attained the temperature within the shed . . . . and the next morning the temperature of the fruit in lugs averaged 68.8° F. This was nearly 10° colder than the coolest fruit brought from the field the preceeding day, and 31° cooler than the warmest fruit."

Cherries picked the first few days sold as fast as they could be harvested. As the volume increased above the sales the first surplus of 98 lug boxes was placed in the iced end of the car on the afternoon of July 21. Thermometers thrust into the center of test lugs showed a temperature of 86° F. With a ton of ice in that end of the car, the fan was put in motion. No salt was added to the ice. At 6:00 a. m. the next morning the temperature of the center fruit of the lugs was 56° F., and the air temperature of the room was 47° F. By 6:00 a. m. the

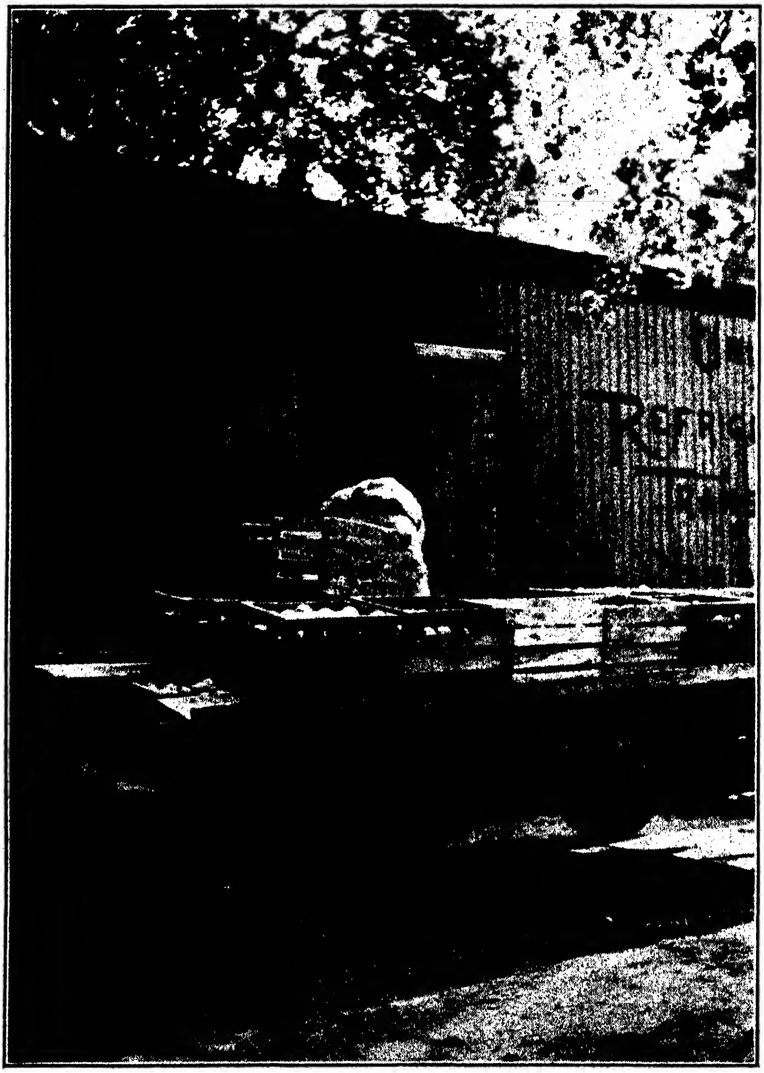

Fig. 4. Note the heavy canvas hanging inside the door to reduce loss of chilled air while loading or unloading fruit. Heavy open packages protect fruit and allow quick chilling.

second morning the center of the lugs showed a temperature of 45° F.

Only a small fan was available. Had a larger fan been used more rapid chilling could have resulted. It has been determined in California (1) that the "center of packages in air moving at 250 feet a minute cooled to 40° F in 8 hours while 10 hours were necessary to secure the same results in air moving at 75 feet a minute".

About 40 tons of cherries were chilled before being marketed. Because of moisture contributed by the melting ice the relative humidity in the car seldom fell below 90 per cent. Possibly because of the high humidity and forced circulation of air, there was practically no sweating of the fruit at that temperature when removed from the storage room. Many buyers commented on the fact that the chilled fruit felt much firmer than the warm, freshly picked cherries. That this point has some practical value aside from keeping quality, has been shown in precooling trials with Florida-grown strawberries in which Rose and Gorman, Jr. (4) have noted, "that cooling strawberries increases their resistance to puncturing . . . . . ."

Peach Storage

Results—On September 8-9 the doors and bunker lids of the car were opened at night and closed during the day to determine the amount of heat loss. The recording thermometer showed a minimum temperature of 60° F. at 6:00 a. m. both out-of-doors and in the car. The car was closed and at 2:30 p. m. the instrument inside the car recorded a maximum of 63° F. Outside the car the air temperature in a shaded shelter reached a maximum of 80° F. at 12:30 p. m. While the temperature out-of-doors was rising 20° F. the temperature inside of the car rose 3° F.

At 3:00 p. m. on September 9 a ton of ice was put into each bunker, filling them nearly half full. The out-of-door temperature was 80° F. and the instrument inside the car showed a temperature of 64° F. when the ice bunkers were closed. The fan was not operated as there was no fruit in the car. The object was to precool the car in readiness for the first Elberta peaches. The inside temperatures fell to 45° F. by 4:00 a. m. This temperature was maintained until peaches were placed in the car for precooling on September 11. The outside temperatures on September 10 and 11 averaged about 70° F.

As the harvest season advanced and fruit ripened faster, markets were not able to absorb the fruit. By September 22, Mr. Schweikert had accumulated 800 bushels of Elberta and J. H. Hale peaches in the car. These were held until October 3, at which time the market price had more than doubled. During these two days the peaches were packed inside the car, as shown in Figure 4, and hauled at night and sold at a profit instead of a loss.

While the fruit was being packed (October 5 and 6), the fruit temperatures for the upper tiers of crates averaged 42° F., and the crates next to the floor racks averaged 36° F. This fruit had been held under ice from 14 to 20 days and was in prime eating condition when sold. From September 9 to October 5, twenty tons of cake ice had been used to chill and hold temporarily approximately 2,500 bushels of peaches.

After the peaches were removed, fall apples were immediately placed

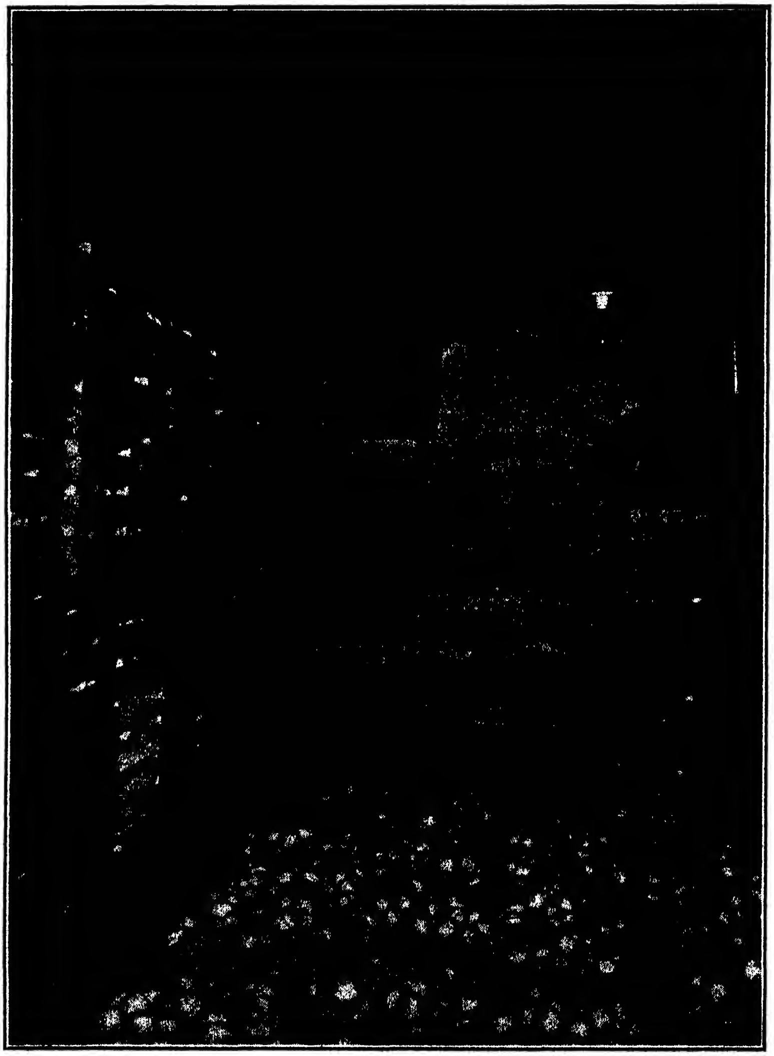

Fig. 5. Note the closing of the upper bunker around the fan outlet. Chilled air is thus drawn through the rotary fan and forced over the warm fruit and returns beneath the floor rack to the ice.
Hygrothermograph shown at the right recorded changes in moisture and temperature day and night during these trials.

in the car. About 1½ tons of ice remained in the bunkers. The fan was operated at night and heat was removed from the warm apples.

Both of the cars described in this article were operated as air-cooled storages for apples during the fall and winter. The owners report that the cars have held at 30°-32° F. during most of the winter and that the fruit has kept in excellent condition.

Summary

Perhaps the greatest need in handling a perishable crop in Michigan is adequate facilities for quickly removing heat from produce before it is marketed or stored. To be able to do this at the orchard is one of the advantages that retired refrigerator cars afford at a very low cost. Furthermore, they can serve later in the season as efficient air-cooled storages.

Literature Cited

1. Allen, F. W. and McKinnon, L. R. Precooling Investigations with Deciduous Fruits. Calif. Agr. Exp. Sta. Bul. 590. 1935.
2. Newell, H. M. and Lloyd, J. W. Air Circulation and Temperature Conditions in Refrigerated Carloads of Fruit. Ill. Agr. Exp. Sta. Bul. 381. 1932.
3. Overholser, E. L. and Moses, B. D. Precooling of Fresh Fruits and Temperatures of Refrigerator Cars and Warehouse Rooms. Calif. Agr. Exp. Sta. Bul. 496. 1930.
4. Rose, Dean H. and Gorman, E. A., Jr. Handling, Precooling and Transportation of Florida Strawberries. U. S. D. A. Tech. Bul. 525. 1936.
5. Wright, Everett. An Unusual Cold Storage. Transactions of the Indiana Horticultural Society, p. 17. 1934.

TOMATO SPRAYING TRIALS

J. H. MUNCIE AND GLENN KENKNIGHT
SECTION OF BOTANY

Tomato leaf spot disease caused by *Septoria lycopersici* is widespread throughout the state and in certain years becomes a limiting factor in production of the crop. Quality as well as tonnage is impaired. Because of defoliation of the tomato plants, fruits are smaller in size, watery and have a much higher acid content.

For many years the standard recommendation for foliage protection from Septoria leaf spot and early blight infection has been some form of bordeaux mixture. This material when applied at the proper time thoroughly and in sufficient quantity has given sufficient protection to enable growers to harvest marketable fruit until frost.

In certain years leaf spot diseases are of only minor importance and make their appearance late in the growing season. Under such conditions if four or five applications of bordeaux mixture have been made, it is often found that the unsprayed plants gave a higher yield of ripe fruit than those receiving the spray applications.

Recently it has been shown by investigators at the Ohio Experiment

Station[1] that applications of bordeaux mixture increased the rate of water loss from the plants and this in itself might account for the lowered yields of sprayed tomatoes.

Since applications of spray material are necessary in the production of quality tomato fruit, especially in seasons like that of 1937, attempts were made to find materials which could be substituted for bordeaux mixture.

Materials Used

The spraying trials were conducted in 1936 and 1937 at Michigan State College. Bordeaux mixture 4-6-100, Oxo Bordo 6-100, Coposil 2-100 and Cuprocide 2-100 were used. Unsprayed plants were left as controls. To obtain better coverage with Coposil and Cuprocide, 4 ounces of a commercial sulphated alcohol were added to each 100 gallons of spray mixture. All the plants were given one application of calcium arsenate 2-100 as a protection against tomato worm.

The 1936 Spraying Trials

The 1936 plats consisted of 80 plants in two rows for each treatment. Plants of the varieties Marglobe, Pritchard, and John Baer were used in the trials. Spray applications were made with a 15-gallon hand pump sprayer mounted on two wheels. On full grown vines the quantity of spray material approximated 300 gallons per acre. Care was taken to cover both lower and upper leaf surfaces and the interior foliage of the large plants. Spray applications were made June 26 and July 15, 20, 28. Septoria leaf spot was first seen on the check plants on September 10. Picking started August 14 and was finished September 22 because of frost just following that date. Production was low and quality poor due to fruit cracking after frequent rains. The yields of marketable fruit in tons per acre are given in Table 1.

Table 1. Results of 1936 spraying trials in tons per acre.

Treatment	Variety		
	Marglobe	Pritchard	John Baer
Bordeaux 4-6-100	3.64	6.07	4.57
Oxo Bordo 6-100	4.05	6.08	5.00
Coposil 2-100	5.08	7.66	5.52
Cuprocide 2-100 plus spreader 4 ounces	5.08	5.57	6.00
Check—No spray	5.90	6.52	6.21

The results of the 1936 trials are marred by the low yield of marketable fruit. However, it appears significant that with each variety, the

[1]Wilson, J. D. and Runnels, H. A. 1937. Five years of tomato spraying. Ohio Agr. Exp. Sta. Bimon. Bul. 22: 13-18.

plats sprayed with 4-6-100 bordeaux mixture gave the lowest yields. It is also to be noted that with one exception (Pritchard sprayed with Coposil) the highest yields were produced on the unsprayed plats. Oxo Bordo follows bordeaux mixture in low yields of each variety. In both these plats the spray material gave a very apparent coating in comparison with the inconspicuous residue of the two other materials used. In only one plat (Pritchard sprayed with Coposil) sprayed with the newer copper compounds was the yield greater than that of the unsprayed check plats.

The 1937 Spraying Trials

Similar trials using the same materials were carried out in 1937. Fifty plants of the Pritchard variety were used in each plat in these tests. Five applications were made as follows: July 6, 13, 20, 27; August 2. Killing frost came on September 16. Leaf spot was first found on August 30 but infection spread more rapidly than in 1936. Estimates of percentage of defoliation due to leaf spot were made on September 12. These were based upon number of dead infected leaves on 5 plants in each plat.

The results of these trials are given in Table 2.

Table 2. Results of 1937 spraying trials.

Materials	Tons per Acre	Percentage Defoliation
Bordeaux 4-6-100	21.71	25
Oxo Bordo 6-100	25.55	25
Coposil 2-100 plus spreader 4 ounces	23.45	35
Cuprocide 2-100 plus spreader 4 ounces	24.42	5
Check—No spray	28.58	40

In these trials it is clearly indicated that bordeaux mixture again depressed the yield and that the highest yields of marketable fruit came from the unsprayed plants. The other materials did not follow the same ranking in production as for 1936. However, plats sprayed with these materials showed higher yields than bordeaux mixture and all were again lower than the unsprayed checks.

Although leaf spot and early blight were more severe in the plats than in 1936, these diseases did not approach in severity conditions in the commercial crop throughout the state. A glance at the estimated percentages of defoliation given in Table 2, shows the severity of the disease on these plats. Plats sprayed with Cuprocide showed the least amount of leaf spot and early blight infection.

Summary

Results of the two years spraying trials upon tomatoes indicate that Oxo Bordo, Coposil, and Cuprocide depressed the yield to a less extent

than did bordeaux mixture 4-6-100. Of these materials Cuprocide 2-100 plus spreader gave the best protection against Septoria leaf spot and early blight. During the two seasons in which infection was not severe, none of the materials used increased yields over those of the unsprayed plants.

The fungicidal value of these newer spray materials under conditions of severe infection in Michigan is not known and until they can be tried under such conditions, bordeaux mixture remains the recommended field spray for control of Septoria leaf spot and early blight.

BULLETIN REVIEWS

Circ. Bul. 164.—Fruits for Year Around Use.—Griswold, R.—A book of recipes for blueberries, cherries, grapes and peaches. (51 pp.)

Circ. Bul. 165.—Celery Production in Michigan.—Sections of Horticulture, Soils, Botany.—A discussion of soils, soil management and fertilizers for celery production; varieties, plant production, culture, blanching, harvesting and storage; insects and diseases and their control. (43 pp., 5 tables, 8 figs.)

Spec. Bul. 289.—High School Communities in Michigan.—Thaden, J. F. and Mumford, Eben.—At all ages and in virtually every county of Michigan the percentage of children attending school is higher for urban children than for farm children. Only 533 of Michigan's 6,671 school districts have a four-year high school. Some 37,000 high school tuition pupils from the non-twelve-grade school districts are attending the 533 four-year secondary schools. The average high school is attended by pupils from 13 school districts. In lower Michigan, the average 12-grade school district covers 13 square miles but serves an area of 88 square miles. A reorganization of school districts on the basis of actual high school attendance—one school district per community—would facilitate town-country unity and cooperation, socialization of farm children, and minimize many contemporary educational problems. (36 pp., 11 tables, 5 figs.)

Tech. Bul. 157.—Bacteriological, Histological, Zymological and Chemical Studies of the Cause of Cucumber Pickle Spoilage.—Fabian, F. W. and Johnson, E. A.—A strain of *Bacillus mesentericus fuscus* was isolated from a tank of spoiled salted cucumbers which was capable of causing "slips" inside of 6 to 12 hours and "mushy" pickles within 12 to 24 hours. It grew readily in salt concentrations of 9 to 11 per cent. Its acid tolerance in these concentrations of salt ranged from 0.15 to 0.20 per cent acetic and 0.2 to 0.3 per cent lactic.

Zymological studies demonstrated that all the members of the mesentericus-megatherium group worked with produced protopectinase, pectase and pectinase as judged by chemical and cytological studies. The enzymatic action was inhibited by 2-per cent salt whereas the organism grew in 11-per cent salt. The enzymes showed a greater acid

tolerance than the organisms. Slippery pickles were produced in 1-per cent acetic and 0.6-per cent lactic acids within 5 days. Salt had but slight effect upon the action of the enzymes in the presence of the acids until a 2-per cent concentration was reached.

Histological studies of sections of normal pickles and pickles that had been cured in either salt or dill brines showed the presence of pectic materials in the middle lamella when stained with ruthenium red. Sections of pickles that had become "slippery" or "mushy" by the action of bacteria or enzymes showed a diminution or the complete absence of the pectic materials when stained with ruthenium red. The influence on pickles of ammonium oxalate and acids such as HCl, acetic, and lactic, as well as of cooking, were studied histologically by staining sections of pickles so treated with ruthenium red. Cross and longitudinal sections of normal fresh and salted cucumbers were also studied to determine why pickles spoil so frequently at the blossom-end first.

Chemical studies were made of the pectic content of normal and spoiled pickles to confirm and check the histological studies. The results indicated that, when pickles became "mushy" owing to bacterial action, the total pectic content is the same as that of normal pickles but there is a two-fold increase of soluble pectin in spoiled as compared with normal pickles. This indicates that the enzyme produced by *B. mesentericus fuscus* within the first 4 days was protopectinase and possibly pectase but not pectinase, since it broke down the insoluble protopectin to soluble pectin and possibly pectic acid but not as far as sugars which result when pectic acid is decomposed. Chemical studies also demonstrated the limited interpretation that may be obtained with ruthenium red when it is used to indicate the presence of pectic materials in spoiled pickles, since it apparently stains only the insoluble protopectin.

It was demonstrated that pickle spoilage may be caused by bacterial enzymes which dissolve the pectic materials in the middle lamella of the cucumber cells or by acid hydrolysis which loosens the protopectin from the cellulose of the cell walls, thereby causing a weakening of the cell structure. (31 pp., 8 tables, 4 plates.)

JOURNAL ARTICLE ABSTRACTS

Identification of Phytomonas, Azotobacter, and Rhizobium or Achromobacter upon Initial Isolation.—Bryan, C. S.—Soil Science 45 *(3):* 185-187. 1938. (Journal Article No. 298, (n. s.) from the Mich. Agr. Exp. Sta.) A large number of media have been suggested as being desirable for the growth of *Rhizobium* and *Azotobacter*. Of these, the nitrogen-free medium of Ashby is desirable. Because of the presence of *Achromobacter* and *Phytomonas* colonies, much confusion results in the determination of the *Azotobacter* content of the soil and in the isolation of *Rhizobium* from nodules. The addition of 20 c. c. of a 1-400 aqueous solution of congo red (1-20,000 final dilution in the medium) affords differentiation of *Phytomonas, Azotobacter,* and *Rhizobium* or *Achromobacter* colonies. The plates must be

capped with the same medium to insure all colonies developing as subsurface colonies. The subsurface colonies of *Phytomonas* are red, those of *Azotobacter* are pink, and those of *Rhizobium* and *Achromobacter* are white. Duplicate dilutions should be plated in a nitrogen-free agar of pH 11; only *Achromobacter* grow in this medium. This plating yields data with respect to count of *Rhizobium* and *Achromobacter* and serves as a means of differentiating between these two organisms.

The Influence of Diet on the Nitrogen Balances of Pre-school Children.—Hawks, J. E., Bray, M. M., and Dye, M.—Jour. Nutrition.—15 **(2):** 125-143. 1938. (Journal Article No. 309 (n. s.) from the Michigan Agricultural Experiment Station.) Five children when they received constant diets containing 3 grams of protein per kilogram of body weight, reacted uniformly by retaining nitrogen in proportion to the slight period by period variations, which had previously been reported in diet. The percentage of intake nitrogen excreted in the urine and feces, however, varied between individuals according to the character of the stools. Therefore, the coefficients of digestibility varied between the children, but they remained fairly constant for each individual child during the several periods.

Immediately following a change to a four-gram protein diet, the nitrogen excretion values were irregular and the retention figures high. After equilibrium, the children still retained the same proportion, although a larger total amount of intake nitrogen than they had on the lower protein diet. The coefficients of digestibility were higher because nitrogen increased less in the feces than in the urine. This suggests that there might have been a constant nitrogen fraction excreted in the feces. All of the children gained more weight on the high than on the medium protein diet. On both diets the variability of the data for urinary and total excretion and for adsorption was practically the same as that for diet.

A Study of the Time of Pasturing Alfalfa.—Rather, H. C. and Dorrance, A. B.—Jour. Amer. Soc. Agron.—30 **(2):** 130-134. 1938. (Journal Article No. 313 (n. s.) from the Michigan Agricultural Experiment Station.) Time-of-grazing trials were conducted in which sheep were pastured on Hardigan alfalfa April 30 to August 28, May 14 to August 28, and May 14 to October 16. Each trial was conducted in triplicate in one-acre paddocks. The first year of grazing resulted in no significant differences, either in returns or effects on the alfalfa under the April 30 to August 28, and the May 14 to August 28. However, the alfalfa closely grazed through September into October, (May 14 to October 16 treatment), contained less dry matter in the roots when winter set in, developed fewer and much less vigorous crown buds, and killed out so badly during the winter that the stands were of no further value. The alfalfa not pastured in the fall showed no indications of heaving or winter injury and excellent stands were available the next season.

The Bulletins of this Station are sent free when available to such individuals as may request them. Please request only those actually needed. Address all applications to the Director, Agricultural Experiment Station, East Lansing, Michigan.

LIST OF AVAILABLE BULLETINS

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262 Suggestions on Planting Orchards.

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83 Key to Orthoptera of Michigan.
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232 The Michigan Pear Industry, Its Status and Trends.
233 Experimental Studies in Feeding Fattening Lambs.

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235 Motor Truck Marketing of Michigan Livestock.
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THE TRADE AGREEMENTS PROGRAM AND MICHIGAN AGRICULTURE

by
MERRILL C. GAY
SECTION OF ECONOMICS

The Trade Agreements Program of the United States government has been in effect now for nearly four years. To date, 17 trade agreements have been consummated and several others are in various stages of negotiation. The importance and influence of these agreements appears to be steadily increasing. Many facts indicate that the program is bringing about, to some extent at least, the originally expressed objectives of loosening trade barriers and enlarging our foreign trade. By 1932 world trade had shrunk by about two-thirds in value and one-third in volume from its 1929 magnitude. The share of the U. S. shrank to an even greater extent than did that of most other countries. The Trade Agreements Program was designed to combat this situation. It is the purpose of this brief survey to consider a few of the most common questions that have arisen in connection with the carrying out of the program with especial reference to Michigan agriculture.

What is the Relation Between American Agriculture and the American Tariff?

Agriculture in the United States normally has produced a large surplus in excess of domestic requirements, and could produce even more if profitable outlets could be found. In other words, it is traditionally an export industry, and would be, even if we excluded all agricultural products that we normally import (except coffee, rubber, etc.). United States agriculture, by and large, does not, therefore, need tariff protection. As a seller of foodstuffs to European consumers we have demonstrated that we were efficient and low-cost producers. In addition to providing for our home market we have produced a surplus to sell abroad. We have always prided ourselves on our great home market, which, incidentally seems unable at present to absorb all of our potential agricultural output. Is it not possible that in our anxiety to keep our home market, American agriculture has acquiesced in a policy of high tariffs, ill designed for its needs? As a buyer of goods, the farmer has been hurt because he was buying in a protected market; and as a seller he has not been helped because he was selling in a world market. What he could get in the world market for his wheat determined largely the price he could get for his entire crop.

It is almost axiomatic that a country cannot sell to other countries if it does not buy from them. Farmers, as sellers, must by the very nature of trade be hurt by restrictions on trade which make it difficult for outside purchasers to buy their products. Perhaps it is not en-

tirely coincidental, therefore, that in 1932, Mid-Western farmers were getting around 30 cents a bushel for corn, 38 cents for wheat, 18 cents for oats, 18 cents per pound for butter, $3.50 per cwt. for hogs, and $4.00 per cwt. for cattle.

Moreover one can reasonably expect that the reduction of export outlets, whatever may be its cause, will have a tendency to bring about a diversion of labor and capital from the production of export crops to the production of domestic crops, i. e. a reduction in the output of export staples with greater emphasis on diversified farming. This development, which would tend to depress the prices of such products, is of especial significance to a state like Michigan, whose farmers produce largely for the domestic market.

Comparing the duties in effect before the Trade Agreements Program came into existence with those now existing, we find that the equivalent ad valorem rate (duty expressed as a percentage of the value of the product) paid by dutiable agricultural imports has been reduced by about 4 per cent, whereas rates paid on dutiable non-agricultural products have been reduced by about 9 per cent. These figures, being in the nature of averages of many specific reductions, are not particularly significant except in so far as they show that reductions on agricultural products have not been disproportionate to reductions in general. Many of the agricultural items upon which the rate was reduced, such as seeds, are consumed chiefly by farmers. On the other hand, hundreds of concessions have been obtained for agricultural products which we export; 125 agricultural and horticultural products were granted reductions by Canada alone. In fact, based on 1929 exports, it appears that approximately one-third of our agricultural exports to Trade Agreement countries received improved treatment in the form of lower duties or increased quotas, and another one-third received guarantees of no worse treatment during the period of the agreement than they were receiving before.

Has the Recent Large Increase in Imports of Farm Products Been Caused by Trade Agreements?

There has been much discussion concerning the increase in imports during 1936-37. By citing the fact that imports of agricultural products reached 1½ billion dollars during this period, or that they increased $699,000,000 over 1933-34, one might get the impression that our markets were being flooded with foreign products. The ingredients of these figures must be considered in order to get a realistic picture of their significance. Approximately $250,000,000 of this increase is accounted for by increased imports of non-competitive articles, i. e. articles not produced by American agriculture, such as rubber, coffee, tea, silk, etc., resulting largely from a general increase in consumer purchasing power in the United States. Approximately $140,000,000 of the increase was comprised of the major items affected by the droughts of 1934 and 1936, products which are usually exported rather than imported. In other words, imports increased because prices were high and kept them from going still higher. Another $45,000,000 of the increase was accounted for by sugar, imports of which we controlled by quotas in such a way as to safe-guard the position of the domestic producer. Much of this increase was accounted for by an increase in

the price of sugar rather than in the quantity coming in. A large part of the remainder consists of agricultural products which we cannot produce in sufficient quantity to sell at reasonable prices and which regularly are imported in spite of high tariffs. According to the Department of Agriculture studies, less than 5 per cent of our agricultural imports in 1937 (excluding sugar which is controlled by quota) consisted of trade agreement items.

Has the Increase in Agricultural Imports Hurt the Michigan Farmer?

It has just been shown that the large increase of imports of agricultural products is primarily due to increased consumer purchasing power and domestic scarcity due to drought conditions. These same general factors undoubtedly explain the recent price movements of farm commodities, shown in the accompanying table.

	Michigan Farm Prices	United States Farm Prices	Ratio of Prices Received to Prices Paid (by farmers)	
			Michigan	United States
1910-14	100	100	100	100
1932	64	65	60	61
1933	73	70	67	64
1934	89	90	72	73
1935	104	108	83	86
1936	120	114	97	92
1937	132	121	101	92

(Source: "Farm Prices and Farm Costs in Michigan"—O. Ulrey)

Columns 4 and 5 indicate the ratio between prices received by farmers and prices paid by them—in other words, the buying power of farm products. It will be noted that this ratio has been of increasing advantage to the farmer and that the Michigan farmer has been relatively better off since 1935 than the farmers of the country as a whole.

Agricultural imports tend to rise and fall as general business conditions fluctuate; they are pretty generally matched by farm prices and farm incomes. The agricultural imports, amounting to 1½ billion dollars in 1937, do not appear abnormally large when viewed in comparison with the average for the period (1926-1930), which was $2,085,000,000. It should be noted, too, that production was not reduced during those years, on account of drought, to the extent it was in 1936. In 1932, agricultural imports were at a minimum and the American farmer was "down and out" with a cash income of only $4,328,000,000. Agricultural imports had, in 1937, more than doubled those of 1932, and likewise cash income had doubled.*

We cannot consider in detail what has happened to all of Michigan's farm products. Let us consider, however, the four groups of products which lead as a source of cash income for Michigan farmers, and which together accounted for about two-thirds of it in 1935: dairy products, livestock, poultry and eggs, and fruit. These groups were all affected by duty reductions in the Canadian Agreement.

*The following table shows the trend in farm incomes for Michigan.

Year	Cash Farm Income for Michigan
1929	$265,000,000
1930	208,000,000
1931	151,000,000
1932	118,000,000
1933	134,500,000
1934	158,000,000
1935	186,000,000
1936	216,000,000
1937	246,000,000

It is not to be inferred from the following discussion that the Canadian Agreement is the only one of significance to the agricultural interests of Michigan. Michigan farmers, however, have been chiefly concerned with increased competition from Canada. Neither is it intended to imply that the improved price and income situation of Michigan farmers is chiefly, or to any considerable extent, caused by the Trade Agreements Program. The farm prices in 1937 appear to have been abnormally high due to the direct and indirect effects of the drought. The tendency for farm prices to drop, which has been evidenced in early 1938, can be viewed as a natural return to a more normal price situation.

Dairy Products—The two products most affected are cream and cheddar cheese. Michigan has supplied Eastern centers with fresh cream, shipments averaging 500,000 gallons in 1933 and 1934. Lowering of the duty on cream was expected to cause some competition from Quebec in these markets. With a retained rate of 35 cents a gallon and the reduced rate applicable to only 1½ million gallons, it seemed unlikely, however, that Michigan producers would be displaced sufficiently to offset the anticipated increase in urban consumption. The imports of fluid cream in 1937, most of which entered the New England territory, were twice as great in value as those of 1936. The average butterfat prices were higher in New England in 1937 than in 1936, and higher there than for the country as a whole. The total import of 137,000 gallons was, however, less than 10 per cent of the annual low-duty quota of 1,500,000 gallons.

The reduced duty on cheddar cheese has caused considerable comment. Considering the fact that in 1933 only 1.3 per cent of the total milk production of Michigan was used to produce this type of cheese, any increased competition felt could hardly affect seriously Michigan's dairy interests. In this connection it is interesting to note that in 1932, when American producers of cheddar cheese enjoyed 99.84 per cent of the domestic market, they were getting 10 cents a pound for their product and their gross income was $37,000,000. In 1936 (the duty cut had gone into effect the first of the year) they supplied 97.78 per cent of the domestic market; their average price was 15.3 cents a pound, and their gross income exceeded $75,000,000. Despite changes in the price level, there was a substantial improvement. In 1937, the importation of Canadian cheddar cheese dropped to less than half of the 1936 figure, both in volume and value, despite the fact that the average U. S. price was higher in 1937 than in 1936. The improved market in the United

Kingdom for Canadian cheese, as well as increased Canadian consumption, largely explains the change.

Let us consider the movement of prices for Michigan dairy products. Using the 1910-14 average as 100, the index of dairy prices stood at 71 in 1932; it rose gradually to 107 in 1935; it jumped to 122 in 1936, and to 137 in 1937. Of course it is impossible to know precisely what these averages might have been in the absence of the import and export factor; it would appear, however, that no serious injury has been done. It is interesting to note that about one-half of Michigan's total milk production goes into the manufacture of butter, upon which the American duty in the Canadian Agreement was left unchanged although Canada reduced hers by 14 per cent.

Livestock—Most Michigan farmers produce livestock. The Canadian Agreement reduced the duty on the imports into the United States of cattle weighing over 700 pounds (within a quota limit of 155,800 head) by one cent a pound. In so far as Michigan farmers are in the habit of bringing in feeder cattle to finish for the Eastern markets, this reduction would appear immaterial. More of the feeder cattle would come from Western Canada and fewer from the Western United States. An increase of Canadian supplies of finished cattle sent to Buffalo and other Eastern markets might prejudice, however, the position of Michigan supplies. It would be expected that this would result in Michigan producers supplying a larger share of the beef consumption of the State. Let us view the recent trends in Michigan livestock prices and the income of Michigan livestock producers. Using the 1910-14 average as 100, we find the index of livestock prices moving from 64, in 1932, to 61, in 1933; 72 in 1934; 118 in 1935; 126 in 1936; and 137 in 1937. The approximate figures for livestock income were: 1934, $91,000,000; 1935, $115,000,000; 1936, $129,000,000; and 1937, $142,000,000. This increase of cash income is especially interesting in view of the fact that imports of all cattle in 1937 were more than double in value those of 1935, and 59 per cent greater than those of 1936. Much of this increase was due, however, to high prices, the increase in number of head imported showing a much smaller advance. In 1936 there were 199,000 head imported, while in 1937 the figure was 245,000 head. The quota for cattle weighing 700 pounds or more was filled in August of 1937, as compared with November for 1936; for calves weighing 175 pounds or less, it was filled in June of 1937, as compared with August for 1936. The low-duty quota on dairy cows was one-third filled during both years. The enlarged imports, however, were insufficient to offset other factors, causing the year's average price of beef cattle to be higher than for any year since 1930. While it is probable that a car load of finished cattle arriving in a base market such as Buffalo may cause temporarily a noticeable drop in price, such temporary shifts are not likely to be of sufficient importance to materially affect yearly averages.

Poultry—The United States imports of live chickens from Canada increased considerably in 1937 over 1936, both in volume and value. In 1936, the value of such imports was $176,000; in 1937 it had jumped to $733,000. Imports of dead chickens declined and are relatively unimportant. However, the national average price of chickens was highest

in 1937 since 1930. The index of Michigan prices for poultry products, using the 1910-14 average as 100, was for 1932, 79; 1933, 89; 1934, 87; 1935, 123; 1936, 116, and for 1937, 118. Most of the chickens marketed out of the state by Michigan farmers—and in recent years it has amounted to less than 5 per cent of those marketed in the state—have been in dressed form. The increased inflow of live poultry, some of which has come into Detroit, should not materially affect our own producers, since only about three-fifths of Michigan's consumption is supplied from local sources.

Fruit—The value of total imports of fruit from Canada in 1937 was 55 per cent larger than in 1936, frozen blueberries registering the greatest gain. There was a slight increase in imports of Canadian apples; imports were $33,000 in 1936, and $39,000 in 1937. Total exports of fruits to Canada were about $1,000,000 more in 1937 than in 1936. This freer two-way trade in fruits between the United States and Canada, reflecting largely seasonal variations, is undoubtedly beneficial to both Michigan and Canadian fruit growers.

Is There Reason to Believe that the Trade Agreements Program Has Actually Helped Agriculture?

While it is possible to view in a general way what has been done for agriculture in the various agreements, it is impossible to measure precisely its effects. To date, the countries with which we have concluded agreements, customarily have bought from us a larger percentage of non-agricultural than agricultural products. In 1935, before the Trade Agreements Program had got under much headway, they bought approximately 25 per cent of our agricultural exports and approximately 40 per cent of our non-agricultural exports. This is explained by the fact that in the case of many of the countries with which agreements have been negotiated, the trade has tended to be complementary rather than competitive—an exchange of non-competitive agricultural products for American industrial products. If the agreement with the United Kingdom is consummated, this condition will be radically changed. Hundreds of our agricultural commodities, however, have received benefits; one-third of our agricultural exports to agreement countries have received duty reductions, and another one-third have received guarantees against derogations of existing treatment. On fruits we have received many concessions. Practically all the agreements have included benefits to the American citrus fruit industry, to dried fruit, fresh fruits, and canned fruits. Some of these benefits are of direct concern to Michigan farmers; indirectly they would tend to benefit Michigan sugar beet growers. Practically all agreements have made concessions on fresh, canned, and dried vegetables. Canada, in particular, made far-reaching concessions which are of especial interests to Michigan. The duty was removed entirely on some vegetables, and on most others the basic ad valorem rate was reduced by 50 per cent. Valuable concessions were also made in regard to minimum specific duties and increased valuations applicable during the season when our vegetables compete with Canadian vegetables. Hog products are another noteworthy illustration. Canada cut steeply her tariffs on fresh pork, hams, and bacon, and moderately her tariff on lard.

There is considerable reason to believe that our exporters have been definitely assisted by the agreements. Taking 1936-37 together, exports of American products to agreement countries averaged 42 per cent more in value than during the two years immediately preceding, 1934-35. The corresponding increase to non-agreement countries was 26 per cent. Much of this increase was caused by powerful influences other than trade agreements, yet the comparatively greater rate of growth to trade agreement countries seems significant. It must be remembered in this connection that drought conditions not only affected our imports but our exports as well. This was especially true in the case of pork. Obviously we could not increase our exports of commodities when the drought left none to export. In the case of imports, the increase in 1937 over 1936 was considerably greater in non-agreement countries than in the case of agreement countries. Many of the commodities required because of the drought could be obtained only from non-agreement countries.

Of especial interest to Michigan is the increase in exports to Canada. They reached a figure of $384,151,000 in 1936, (the Agreement became effective January 1, 1936) an increase of $60,957,000 over 1935. Imports from Canada rose to $375,832,000, representing an increase of $89,388,000 over 1935. Comparing the first nine months of 1937 with the corresponding period for 1936, we find that exports gained 38 per cent while imports gained 21 per cent. These changes in 1937 no doubt reflect the more normal tendencies, since the effects of the drought were wearing off. Considering only agricultural products, our exports to Canada in 1937 were increased over those of 1936. We imported fewer agricultural products from Canada in 1937 than in 1936. The increase in agricultural exports was due to Canadian duty reduction, increased Canadian purchasing power, and to larger United States crops. The decrease of imports of agricultural products from Canada was accounted for chiefly by cessation of imports of wheat when the domestic crop came on to the market. There was an increase in exports of grain to Canada in 1937, some export of livestock and meat, and a marked increase in our exports of fruits and vegetables—important Michigan products. The following table would seem to indicate that duty reduction had something to do with the increased exports to Canada.

Year	Agricultural Exports on which Duties were Reduced Under Agreement	Other Agricultural Exports to Canada
1935	$12,298,000	$31,546,000
1936	17,229,000	35,104,000
1937	33,283,000	33,346,000

When imports come into the country and compete with domestic supplies, apprehension on the part of domestic producers is natural. If there is any injury it captures our attention; it seems direct and preventable. If it can be claimed that imports lower domestic prices

(or more accurately, with reference to 1937, retard the rate of increase in prices), it would seem equally probable that increasing exports would have the opposite effect.

Are the Indirect Effects of the Trade Agreements Program Worth Considering?

It is perhaps human nature to be concerned primarily with the direct effects of an action while maintaining indifference where indirect consequences are concerned. However, we must not overlook the indirect long-run effects to be expected from the Trade Agreements Program. As a matter of fact, it is to no small extent a long-run program. In many cases, however, the displayed results have been more immediate than were expected. It would seem that Michigan farmers in particular would receive their greatest benefits indirectly. It is recognized that Michigan farmers produce primarily for markets within the state—a rather highly diversified type of agriculture. Michigan ranked fourth among the states of the union in 1929 in the value of its direct exports, which were estimated at $355,000,000. By 1932 the state had dropped to ninth place, with exports declining to $49,000,000. For the country as a whole, exports declined 69.4 per cent during this period, whereas Michigan suffered a decline of 86.2 per cent. In 1929, exports of automobiles, trucks, and parts, amounted to $278,000,000, or 80 per cent of the total exports of the State. By 1932, such exports had shrunk to $25,000,000.

Most of the agreements contain duty reductions on American automobiles as well as many other types of machinery. Michigan's unique dependence on this type of industry is well known. Regaining and expanding the foreign markets for such products is of tremendous concern to Michigan's industrial population. It is undoubtedly true that to a very considerable extent, the welfare of Michigan's farmers is dependent on the welfare of Michigan industry. The so-called "indirect effect" on Michigan agriculture, which would come through an enlargement of the purchasing power of Michigan's industrial workers made possible by broader markets for industrial products, is indeed something not to be overlooked.

Has Our Pursuance of the Most-Favored-Nation Principle Marked Us as a "Poor Trader"?

Much misunderstanding has arisen over this issue. When we grant a concession to any country, the concession is "automatically" passed on to every other country so long as they in no way discriminate against our commerce. We are not giving away something for nothing. We are in effect making a trade with each and every one of these countries receiving the concessions. We are giving them an equality of treatment in exchange for a similar treatment toward us. It is decidedly a reciprocal affair, pursued by all countries for the same selfish reason that any exchange is undertaken. How is a farmer affected by this policy? It is estimated that in 1936 there was imported into the United States $7,000,000 worth of agricultural products at duties reduced through trade agreements from non-trade-agreement countries. In the absence of a generalization of these duty reductions, it is likely

that some part of this $7,000,000 worth of farm products would have come in from the trade agreement countries themselves. It does not therefore represent a net increase of imports. Despite this generalization of concessions, four-fifths of the imports of duty-reduced agricultural products came in from trade agreement countries. This is because the duty reductions granted in a trade agreement are on commodities of which the contracting country is the leading supplier. It should therefore get most of the benefits. Provisions are inserted in the various agreements whereby remedial action can be taken if it is found that some third country gets the greater benefit.

We previously exported hundreds of millions of dollars worth of agricultural commodities. If we followed a policy of discrimination, we could reasonably expect to be discriminated against. Thus we would run the risk of jeopardizing these huge export outlets, to the detriment of American agriculture. To assure ourselves equality of treatment in return for extending to a few countries duty reductions on $7,000,000 worth of products seems an excellent trade. To follow the opposite course would lead to trade diversion, trade restriction, endless "higgling," insecurity, and ill feeling. We received in 1936, from France and Canada alone, generalizations affecting $4,000,000 worth of agricultural products. The Canadian generalizations are of especial interest to Michigan agriculture. The contention which is sometimes made that we are "giving away something for nothing" is based upon a misconception of the true meaning of most-favored-nation treatment.

Does Agriculture Stand to Gain from an Enlargement of the Trade Agreements Program?

A failure of American agriculture to regain its lost export markets would appear to presage a pursuance of arbitrary crop curtailment plans. American price policy has undoubtedly been a factor in stimulating production abroad and diverting foreign purchases to such sources. The possibility of a vicious spiral of price controls and nationalistic production plans abroad is indeed unpleasant. The Trade Agreements Program has been a step away from this course.

Of the greatest significance to American agriculture will be the consummation of an agreement with the United Kingdom, our greatest foreign market. Our exports to Great Britain, the British Colonial Empire, and Newfoundland, comprise 20 per cent of the total. Adding to the 17 trade agreement countries the United Kingdom and the other three with which negotiations are under way, we have a group of countries which bought 58 per cent of our agricultural exports in 1935. This should make it possible to sell in larger quantities and at better prices. Our potential exports of cured pork to the United Kingdom will serve as an illustration. Prior to the depression we sold to the United Kingdom around 150,000,000 pounds annually. The United States is now restricted to 8.1 per cent of the quota allowed to non-Empire countries. This share has averaged in the last three years about $45,000,000 annually.

The United Kingdom is the world's largest fruit importer. Preferential treatment is granted on fruit from the British Dominions, however, to the prejudice of American fruit exporters. The United States, in the trade agreements negotiated to date, has made more progress in

securing duty reduction on fruit than on any other group of American agricultural export products. A corresponding degree of success in entering the British market would be a significant achievement.

The Trade Agreements Program is of an unfolding nature. Its benefits should be cumulative. American agriculture has much to gain from it. It must be recognized, of course, that a program of reciprocal tariff bargaining involves the principle of give and take. Perhaps American agriculture, and perhaps Michigan agriculture, has had to do a measure of the "giving". To appraise the success of any "trade," however, it is necessary to weigh that which is given against that which is received.

The Trade Agreements Program is only one of many diverse factors which affect our complex economic situation, and it is exceedingly difficult to isolate the effects of any one factor. If the program can be carried on in the spirit of fairness and cooperation it is reasonable to expect both direct and indirect advantages to continue.

Data of a statistical nature presented above were derived from reports and releases of the Departments of Agriculture, Commerce, and State, excepting that pertaining directly to Michigan. For the latter, dependence was placed on reports of the Michigan State College Agricultural Extension Division.

Further information pertaining to the effects of Trade Agreements on particular commodities, or the trend in the trade relations with particular countries, can be obtained from the Trade Agreements Division of the Department of State, Washington, D. C.

FURTHER STUDIES ON PRESERVATION OF APPLE JUICE BY FLASH PASTEURIZATION

ROY E. MARSHALL AND J. C. KREMER
SECTION OF HORTICULTURE

One year ago the writers* made a preliminary report on the sterilization of apple juice by flash pasteurization and presented specifications for the building of a heat interchanger for such purpose. Subsequently apparatus having two coiled, flattened tube units was constructed so as to make it suitable for varying the length of time for heat interchange, varying the capacity in terms of gallons per hour, and adaptable to the filling of flash-heated juice directly into bottles or to flash cooling the juice immediately after heating, but before bottling.

Construction of Equipment

The tubes for the conduction of the juice through the steam jackets were made of heavy block tin one-half inch in diameter. Attempts to flatten this block tin, to provide an opening approximately 3/32 inches thick, by running it through a tinsmith's roller several times resulted in a dishing or concaving of the material. The method finally adopted for flattening and coiling the tubing to provide an opening of uniform thickness is as follows: Run the block tin tubing forward and backward

*Marshall, Roy E. and Kremer, J. C. Sterilization of Apple Juice by Flash Pasteurization. Mich. Agr. Exp. Sta. Quart. Bul. 20:1:28-34. 1937.

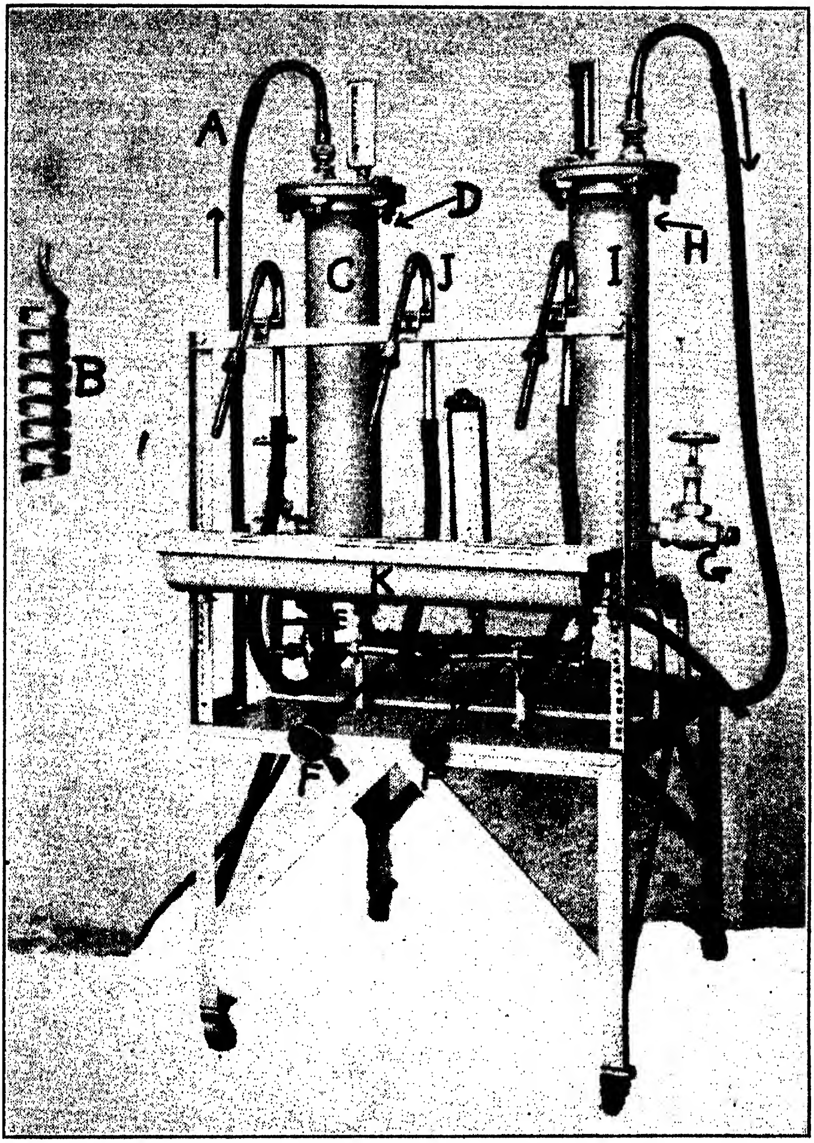

Fig. 1. Flash pasteurizer used during 1937-'38 season. C and I are standard 4-inch pipes, the former jacketing 10 feet of coiled, flattened tubing like that shown at B, and the latter houses 7 feet of coiled, flattened tubing. The juice enters the heating unit (C) at A. Either of the control valves (F) may be used to regulate rate of flow and temperature of juice. I is the cooling unit. Steam is admitted to the steam jacket on the back side of C at D and leaves the chamber through a jet at E. Cool tap waters enters I at G and is released through an outlet on the back side of I at H. The outfit is equipped with three siphon fillers (J) which may be fed from either the heating unit (C) or the cooling unit (I). K is a grated support for bottles and drain for overflow.

through a tinsmith's roller three or four times to flatten slightly. Then fill the tubing with granulated sugar (do not compact) and continue flattening by making several runs through the roller until the outside thickness indicates a proper inside thickness for the opening. Then place a round stick or rod of proper diameter (2 inches in this case) in a lathe and turn the lathe slowly by hand while feeding the flattened tube to form the coil. The finely powdered and much compacted sugar is then dissolved out by laying the formed coil in a hot water bath and connecting one end to a hot water faucet. Several hours may be required to dissolve all the sugar. The writers have not had experience with stainless steel but suggest the same method if this material is used.

The left-hand steam jacket of Fig. 1 contains 10 feet of tubing flattened to an inside thickness of approximately 7/64 inch and the right-hand steam jacket contains 7 feet of tubing flattened to an average inside thickness of approximately 9/64 inches (calculated by determining volume of finished coils). The actual rate of heat transfer through the tubing was found to be slightly in excess of 500 B.T.U. per hour per square foot of tubing for one degree difference in temperature for the right-hand unit and approximately 400 B.T.U. for the left-hand unit. Thus, the tubing with the thinner opening for the juice flow is considerably more efficient.

The longer or left-hand tube was found to deliver an average of 55 to 57 gallons per hour when the temperature of the apple juice was raised from 50° to 190° F. and the temperature in the steam jacket averaged about 222° to 224° F. Under these conditions the capacity of the right-hand tube was slightly less than 35 gallons per hour. A boiler supplying steam for the larger capacity unit should be capable of converting about 10 gallons of water into low pressure steam each hour.

The use of siphon bottle fillers mounted as shown in Fig. 1 and connected to the outlet end of the coil by means of flexible rubber tubing greatly facilitated bottle filling and when sterilized bottles were being filled with cooled juice these fillers kept the mouths of the bottles covered. When the siphon fillers are used to fill bottles with juice at 190° F., the displacement of the filling tube in the bottle is sufficient, however, to result in short volume in the bottle after the juice has cooled and contracted, unless care is taken to fill the bottle completely as it is removed from the filter.

The double unit outfit as shown in Fig. 1. was constructed at a cost of $100, which includes all labor and materials involved in rebuilding portions that failed to meet specifications. A single heat interchanger similar to the left hand unit, mounted on a wall bracket, capable of delivering 50 to 60 gallons of 190° F. juice to bottles or cans and equipped with satisfactory thermometers can be constructed for less than $50. Where stainless steel is used for the flattened tube, the cost would be higher but the unit would be more rigid, less subject to erosion and corrosion and would provide a slightly higher rate of heat transfer. Equipment of larger capacity would cost correspondingly more. The double unit equipment would be necessary only when the juice is to be flash-cooled immediately after flash-heating, as discussed later.

Flash Pasteurization and Bottling of Hot Juice

During the last season 15 lots of apple juice were heated to approximately 190° F. and filled immediately into pre-warmed, but unsterilized, bottles. In most cases the juice had been clarified with an enzyme (Pectinol) and rough-filtered before it was subjected to the heat treatment. There were no losses due to micro-organisms such as yeasts, molds and bacteria. A few bottles of two lots became roily after four weeks storage at 70° F. followed by two to three months storage at 36° F. The cause of this condition has not been determined, though the station bacteriologists report that no micro-organisms were present.

When these various lots, together with bottles or cans of available brands of apple juice purchased on the open market were coded and subjected to tasting tests, the experiment station samples invariably rated higher than the open market brands, most of which were probably sterilized by pasteurization in sealed containers or by tubular (round) flash pasteurization (about 40 seconds).

This method of running the hot juice (190° F.) into clean and warm, but unsterilized, bottles or cans is a very safe method of preservation and can be recommended generally. To sterilize the crowns thoroughly, the bottles should be laid on their sides for a few minutes after sealing. Cans should be allowed to roll slowly in a horizontal position for 20 to 30 seconds before they are cooled in a water bath or under a water spray.

Relation of Clarification and Filtration Treatments to Taste of Pasteurized Juice

On December 15, a 50-gallon lot of freshly expressed apple juice was divided in five lots for as many treatments subsequent to expression of juice and prior to flash pasteurization on December 17. All lots were treated alike during the course of pasteurization, bottling, and storing. The five treatments were: 1. None, i.e., no clarification and no filtration; 2. Enzymic clarification, juice siphoned from container so as not to disturb sediment; 3. Enzymic clarification followed by filtration; 4. Filtration without previous clarification; and 5. Enzymic clarification, filtration, and de-aeration. These bottled lots were coded and 14 individuals were asked to rank them with respect to the amount of detectable apple flavor and freedom from pasteurized taste. The writers ranked the lots on the basis of appearance. When the individual ratings were summarized it was found that Lot 4 was rated highest for appearance, apple flavor and freedom from pasteurized taste. There was little difference between Lots No. 3 and 5 for each of the three qualities, but they were slightly poorer than 4. Lot 2 was given a low rating for each quality and Lot 1 still poorer ratings.

These tests substantiate unpublished conclusions of the previous season to the effect that unfiltered juice contains materials in suspension that become "fixed" during heat treatment resulting in cloudiness and that these suspended materials result in more pronounced pasteurized or cooked tastes. Clarification and filtration may remove some of the apple flavor, but in these tests the pasteurized taste of unfiltered juices was strong enough to mask or hide such apple flavor

and the filtered juices were therefore given higher ratings for apple flavor than unfiltered ones.

Flash Pasteurization Followed by Flash Cooling

Between January 13 and March 10, 1938, six lots of juice involving more than a thousand quart bottles, were processed by raising the temperature of the apple juice from 50° F. to 190° F. in about three seconds by passing it through the left unit of the pasteurizer, held at 190° F. for about two seconds, then cooled from 190° F. to 115° or 120° F. in three seconds and filled into bottles which had been sterilized in a calcium hypochlorite solution. Most of the bottles were stored at 70° F. for two to four weeks to furnish favorable temperature conditions for the growth of micro-organisms and then were transferred to 36° F. storage until about mid-June when every bottle was subjected to a critical examination. No cases of fermentation or bacterial action were noted. Approximately 2 per cent of the bottles showed more or less development of a spongy-like mass of mold mycelia. Most of these bottles were found in the last run of 309 bottles when an inexperienced man crowned the bottles.

This method of flash cooling immediately after flash heating has several virtues. The juice has a less pronounced cooked or pasteurized taste than juice bottled at the pasteurizing temperature; the cooler bottles can be handled without gloves or mittens; less trouble is experienced in getting sufficient juice into the bottles to make ample volume at subsequent storage temperatures, and finally, the juice seems to stand up better if free from live organisms than the juice bottled hot, i.e., it remains freer from sediment or roiliness.

The writers believe they are warranted in recommending flash heating followed by flash cooling to a limited extent. They suggest the following precautions. Before cool tap water is turned into the cooling jacket (right-hand unit of Fig. 1) the system should be thoroughly sterilized by allowing three or four gallons of the flash-heated juice to flow through the coiled tube of the cooling unit and through the siphon fillers into bottles. The filling tubes of the siphon fillers should be sterilized occasionally during operation by immersing the tubes in a bottle of chlorine solution for a few seconds. The crowns should be in a chlorine solution having a concentration of at least 300 p.p.m. and the solution should be deep enough to force the operator of the crowner to immerse one hand in the solution when reaching for a crown. Bottles must be sterilized before filling. One of the writers* has devised a simple sterilizer for the chlorine treatment of bottles that may be operated by one man as rapidly as bottles are required for filling from the pasteurizer.

After this juice is bottled it should be held at room temperature for at least two weeks or at lower temperatures for longer periods to allow organisms a chance to develop. Any bottles showing a sponge-like mass in the lower third of the bottle or a blue mold scum in the bottle neck should be discarded and the balance of the juice merchandized. There is little likelihood of mold developing in perfectly sealed containers after the first few weeks.

*Marshall, Roy E. A Bottle Sterilizer for Small Capacity Plants. In process of publication in Fruit Products Journal.

The writers have had much greater success with flash heating followed by flash cooling during the last season than during the preceding one. They believe that the difference in results is largely due to the installation of the siphon bottle fillers; however, there is a possibility that pin holes may have developed in the very thin tubing of the flash pasteurizer used in the first tests.

PRUNUS MEXICANA AND PRUNUS HORTULANA AS ROOTSTOCKS FOR PEACHES

STANLEY JOHNSTON
SECTION OF HORTICULTURE

Horticultural investigators and nurserymen have for many years experimented with various plum species as rootstocks for the peach in the hope that by so doing trees of greater hardiness might be obtained or that they would be more vigorous and productive, or more free from attacks of the destructive peach tree borer. Certain plum stocks have been used to dwarf the peach; in more recent years it has been thought possible that peach trees grown on plum roots might be more resistant to certain of the virus diseases that often take a heavy toll in peach orchards. Limited trials have been conducted with two such stocks, *Prunus mexicana* and *Prunus hortulana,* at the South Haven Experiment Station.

Some years ago a number of trees of *Prunus mexicana* were top-budded to the J. H. Hale peach. Though the J. H. Hale is naturally a semi-dwarf type of tree, it was still further dwarfed when budded on this species of plum. The graft unions were very poor, the trees short-lived. It was clearly demonstrated that there is a lack of congeniality between *Prunus mexicana* and the peach.

More recently, in 1934, a number of South Haven and Elberta peach trees were planted on the farm of F. M. Barden and Sons near South Haven. These trees had been grown in the nursery on seedlings of *Prunus hortulana,* which has been considered one of the most promising of the plum

Table 1. The influence of Prunus hortulana as a rootstock for peaches on size of tree. (Fourteen trees in each lot. Planted in 1934, and measured at the end of four year's growth.)

Variety and Rootstock	Average Trunk Circumference in Inches
Elberta on *Prunus hortulana*	10.4
Elberta on peach	11.8
South Haven on *Prunus hortulana*	10.4
South Haven on peach	12.1

species for this purpose. Other trees of the same varieties growing on peach rootstocks were planted at the same time for comparison. In 1938 the circumferences of the trees were taken, with the results shown in Table 1.

The data presented in Table 1 show that the trees growing on peach roots were significantly larger than those growing on rootstocks of *Prunus hortulana*. Several of the trees on *hortulana* roots died during the four-year period (Fig. 1). There was also greater variability in size among the trees growing on *hortulana* roots. These findings are in harmony with those of Hutchins in connection with his investigations of the phony peach disease and nematode resistance in peach trees.*

Fig. 1. The peach trees on the right are four years of age and growing on common peach rootstocks. Those on the left are the same age and are growing on rootstocks of *Prunus hortulana*. Note the difference in size of the trees. In the left foreground is a tree on *hortulana* roots that has died.

No evidence is yet available from this experiment to indicate whether peach trees growing on *Prunus hortulana* roots are more resistant to virus diseases. Peach borer damage was not apparent in either lot of trees. Though resistance to virus diseases and borers is an important consideration, this experiment would indicate that at the present time those troubles are not sufficiently serious in the well-managed peach orchard to off-set the small size, variability in growth and loss of trees that would result among trees grown on rootstocks of *Prunus hortulana*.

*Nematode—Resistant Peach Rootstocks of Superior Vigor. Hutchins, L. M., Proc. Am. Soc. Hort. Sci. 34:330-338. 1936.

THE KALHAVEN PEACH

STANLEY JOHNSTON
Section of Horticulture

Since 1924 one of the major projects of the South Haven Experiment Station has been peach breeding. Among other objectives in this work, one of the most important has been an attempt to develop suitable yellow freestone varieties maturing from a week to several weeks earlier than Elberta. One step toward this objective was made in 1932 when the Halehaven peach was introduced. This variety matures about 17 days before Elberta and since its introduction has made a sufficiently good record to be accepted as a standard variety of its season.

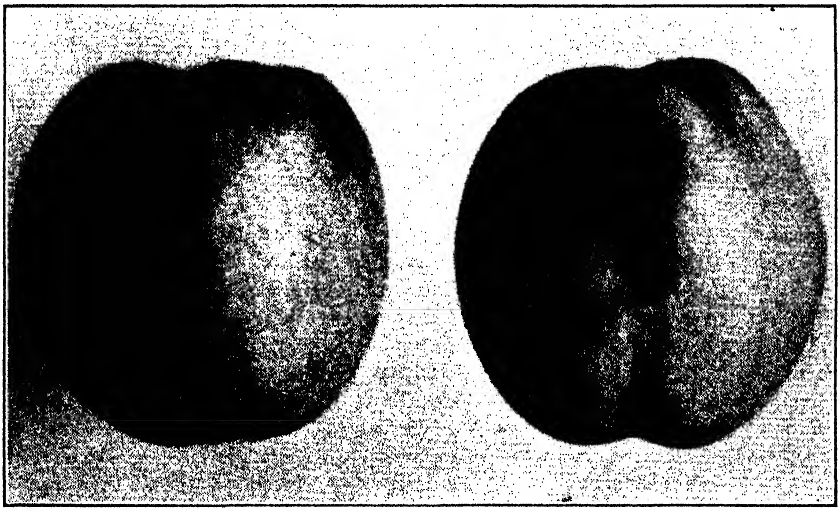

Fig. 1. The Kalhaven peach, about two-thirds natural size.

It is hoped that a second step toward the development of promising peach varieties maturing before Elberta has been reached with the introduction of a new variety resulting from a cross between J. H. Hale and Kalamazoo made in 1924 and which has been named Kalhaven. This variety matures from four to seven days before Elberta.

The tree of Kalhaven is medium in size, vigorous, productive and apparently considerably above average in hardiness of fruit buds. The blossoms are self-fertile. It tends to set fruits abundantly and will require careful thinning most years to obtain fruits of proper size.

The fruits are medium to large in size and a little longer in axial than in transverse diameter. The ground color is a rich yellow overlaid with an abundance of bright red. Pubescence is slight. The skin is thick and tough which has resulted in good shipping ability. The flesh is yellow, fine-textured, of good quality and somewhat red at the pit, although not more so than the J. H. Hale.

While it is considered worthy of commercial trial, like all new varieties, Kalhaven should be planted in small numbers until more is known about it under a wide range of conditions.

THE SENECA CHERRY FOR TRIAL PLANTING IN MICHIGAN

WALTER TOENJES
Section of Horticulture

Recent efforts among tree fruit breeders have been directed towards the production of new varieties possessing characters that will enable them to meet certain requirements not now met by the better known standard sorts. Some of these are either more productive, have larger or more highly colored fruits, possess better fruit keeping qualities, more desirable tree characters, or they extend the fruit harvesting season by maturing their crop at an earlier or later period than the older standard varieties planted in past years.

One of these newer varieties of fruits, which has been developed by the New York Agricultural Experiment Station, is the Seneca sweet cherry. This variety has been under observation at the Graham Experiment Station at Grand Rapids for several years. It is so much earlier in maturing season than any of the varieties commonly grown that it should prove valuable for many cherry growers in Michigan. The harvesting dates recorded at this station fall between June 13 and 18, which is from 20 to 24 days earlier than the first picking dates of adjacent Schmidt sweet cherries, and from 14 to 16 days earlier than Black Tartarian. Its fruits resemble those of Black Tartarian in color and shape, but are slightly smaller in size. The flesh is red, fairly firm, separating readily from the pit, and is of very good quality. The cherries have not shown any greater inclination to crack during rainy periods than those of the Schmidt, nor have they shown as much susceptibility to the attacks of brown rot. Another commendable feature of this new variety is that the fruit is ready for picking, or has already been harvested by the time that the cherry fruit fly makes its appearance, and likewise before the fruit is seriously attacked by the black cherry aphis. No fruit variety, however, is without its faults. The Seneca is particularly subject to the attacks of birds because of its early season of maturity; it has a tendency to "shell" if permitted to become a little too ripe before picking. These faults can largely be overcome, however, by using devices to frighten the

birds and by harvesting the fruits before they reach the over-ripe stage.

The trees are vigorous, hardy and productive. As grown at this station the trees have shown a tendency toward a distinct leader type of trunk growth, from which the branches arise at nearly right angles in whorls or rings. The foliage is fairly abundant and large and to date has shown no particular susceptibility to the attacks of cherry leaf spot.

Since Michigan is one of the few eastern states having areas favorable for growing the sweet cherry, it is suggested that fruit growers interested in planting more sweet cherry trees give the Seneca a trial. Owing to its very early maturing period, its good flavor, and fair handling qualities it should prove profitable for local market and perhaps for shipping short distances.

HOMOGENIZATION AS A MEANS OF STABILIZING THE FLAVOR OF MILK

G. M. TROUT AND I. A. GOULD
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A clean, sweet, pleasant flavor is the one supreme quality which milk must possess if it is to be consumed as fluid milk. The methods of production and handling milk have been developed and supervised so that bottled fresh milk today has a low bacterial count and possesses a flavor which can not be severely criticized. Yet, all milk purchased fresh is not consumed entirely while fresh, but may be held in the home refrigerator from two to four days or even a week before final consumption. The introduction of the electric refrigerator to the home; the constant admonition to buy foods in quantity; and the availability of cash-and-carry milk stores have changed many milk customers from daily delivery to tri- or bi-weekly purchasers. Consequently, the stability of the clean, fresh, flavor in the milk cannot be over-emphasized.

Flavor Defects of Refrigerated Milk

That milk develops taints and "off" flavors as a result of bacterial growth when inadequately refrigerated is common knowledge. However, few patrons fully appreciate the flavor changes of a chemical nature often induced through enzyme activity when the milk is adequately refrigerated and stored for a reasonable period of time. Inasmuch as milk is a biological medium these bacterial and chemical changes, which affect the flavor, are normal.

A percentage distribution flavor study (12) of bottled raw and pasteurized milk, when fresh and when adequately refrigerated for three days, indicated that the development of rancidity was the major flavor change to be expected when holding raw milk at temperatures un-

favorable to bacterial growth. This rancid flavor is frequently referred to as "bitter", "strong", or "soapy".

On the other hand, the flavor changes in the held pasteurized samples were toward the metallic, flat, stale, oxidized flavors, all of which portray a decided lack of freshness. Many synonyms, depending apparently upon the stage of development of the off flavor, are to be found in the literature for this class of flavor. The more common terms are "cappy", "cardboard", "papery", "oily", "meaty", "tallowy", "metallic", and "stale". Occasionally the flavor is referred to as the "flat winter" flavor inasmuch as during the winter season it is likely to be the most troublesome. Patrons, and some distributors as well, frequently refer to this flavor as "pasteurized". However, the flavor to which reference is made is unlike a pasteurized or cooked flavor, and furthermore, is not present at the completion of the pasteurization process, but often develops in the pasteurized product upon storage. The commonly accepted term describing this flavor is "oxidized", which will be used hereafter in this paper.

Possibility of Stabilizing the Desirable Flavor of Milk

Stabilizing the clean, sweet, pleasant flavor against rancidity is readily accomplished through heat treatment, as the enzyme, lipase, responsible for the flavor change is inactivated during pasteurization. The flavor of properly pasteurized milk, therefore, because of the pasteurization exposure, is stabilized against this type of flavor change.

However, the flavor of pasteurized milk particularly during the winter months is often unstable, because various stages of the foregoing oxidized flavor develop upon storage; during the last decade this condition has been increasingly troublesome.

Because milk to be homogenized must be heat-treated to prevent the development of rancidity (3) (4); because homogenized milk must be clarified to eliminate sedimentation (10); and because homogenization of pasteurized milk does not impair the initial flavor (11), indicate the processes incident to homogenization, as well as the process itself, may be an important one in stabilizing milk flavors. Furthermore, many observations on the flavors of commercial and experimental homogenized milk indicate that proper homogenization may possibly play an important role in stabilizing the flavor of commercial market milk for a reasonable period of time.

Several investigators have noted the effects of homogenization on the development of tallowy or oxidized flavors.

Holm *et al.* (5) showed that homogenization of milk prior to drying improved the keepability of the powder as far as the development of tallowiness was concerned. Tracy *et al.* (9) observed that milk homogenized and stored at 40° F. for 24 hours did not develop tallowiness even when copper was added while the milk unhomogenized developed a very intense tallowy flavor under similar conditions of storage. Doan and Minster's (2) researches led them to suggest that homogenization may tend to retard the development of tallowiness in milk.

Hood and White (6) noted the flavor quality of samples of pasteurized and homogenized milk from two plants when stored at 40° F. for various periods of time. After 96 hours both classes were reported as having satisfactory flavors. They concluded that when these milks

were kept in a refrigerator away from light at a temperature of 40° F. there was no noticeable change in flavor or odor after a period of seven days. Babcock (1) observed that pasteurized milk homogenized at 140° F. remained of good flavor upon aging. Trout *et al.* (11) working with fresh homogenized pasteurized milk, noted that homogenization of pasteurized milk did not impair the initial flavor or bring about any undesirable flavor, during the initial 24-hour period.

Thurston and co-workers (8) observed no oxidized flavor development in copper-contaminated homogenized milk held for three days. Ross (7) demonstrated that the development of the oxidized flavor was prevented entirely by homogenization at pressures of 1,500 pounds per square inch or above. These pressures were equally effective in preventing the development of the "off" flavors when copper was added after homogenization.

On the contrary, the studies of Tracy *et al.* (9) and of Hood and White (6) show that unless homogenized milk is kept away from light it is subject to sunshine flavors similar to regular pasteurized milk.

Experimental

Mixed milk delivered to the Michigan State College Creamery was used in these studies. The milk was holder-pasteurized in cans set in a tank of temperature-controlled water. In the majority of trials, unless otherwise stated, the copper sulphate solution, which was used to induce oxidation, was added immediately at the close of the holding period. Following this contamination, the milk was processed at controlled pressures in a 200-gallon capacity viscolizer. Samples of the homogenized milk were taken directly from the machine into glass bottles, were cooled at once, and were stored at 40° F. for periods ranging from 48 hours to one week, depending upon the particular study. At the end of the storage period the samples were examined organoleptically for "off" flavors, particularly the oxidized flavor, by two judges working independently. The samples were keyed in such a manner that their identity at the time of scoring was unknown to the judges. The various intensities of the oxidized flavors were designated as follows, the numbers being used in computing averages in tables:

–	no oxidized flavor	0
?	doubtful oxidized flavor	1
+	slight oxidized flavor	2
++	distinct oxidized flavor	3
+++	very strong oxidized flavor	4

The Flavor of Copper Contaminated Pasteurized Milk Homogenized at Various Pressures

During the late fall and winter of 1937 and 1938, trials were performed on several lots of milk to note the effect of homogenization on the stability of the flavors. In this first experiment varying small quantities of copper, as solutions of copper sulphate, were added after pasteurization and prior to homogenization to five lots of clean flavored milk. Each lot was divided into four portions which were homogenized at 0, 1,000, 2,000, and 3,000 pounds pressure respectively. The milk was stored in quart milk bottles at 40° F. until examined for flavor, which

Table 1. The flavor of homogenized copper contaminated pasteurized milk after 48 hours storage.

Lot No.	Cu (ppm.)	Oxidized Flavor at Various Homogenization Pressures (lbs. per sq. in.)			
		0	1000	2000	3000
1	0.00	+	?	?	−
2	0.25	++	?	−	−
3	0.50	++	+	−	−
4	0.75	++	+	−	−
5	1.00	+++	+	−	−
6	1.25	+++	++	?	?

was usually at the end of a 48-hour holding period. However, in some instances the milk was held even longer before scoring. The data obtained on three trials are presented in Table 1.

Homogenization at 1,000 pounds pressure did not prevent entirely the development of the oxidized flavor which was evident in the copper contaminated unhomogenized products. However, low-pressure homogenization slightly retarded its development. Higher pressures of 2,000 and 3,000 pounds, respectively, prevented the oxidized flavor development. As shown in the table, the presence of oxidized flavor in some of the samples processed at these pressures was questionable. However, a person unused to examining milk for flavor likely would not detect any "off" flavor in the samples.

One series of samples treated and processed as above was held for one week before scoring. Strikingly, the samples homogenized at the high pressure possessed a clean, rich, nutty flavor, the presence of which made identification of the properly homogenized samples relatively easy in contrast with the very oxidized unhomogenized samples. Stability of the original flavor seemed to be attained only when the milk was homogenized above 1,000 pounds pressure.

Table 2. The inhibiting effect of various homogenization pressures on the development of the oxidized flavor.

Trial No.	Oxidized Flavor Development at Various Homogenization Pressures (lbs. per sq. in.)						
	0	500	1000	1500	2000	2500	3000
1	+++	+++	+	−	−	−	−
2	++	+++	++	−	−	−	−
3	+++	+++	+	−	−	−	−
4	+++	++	+	−	−	−	−
5	+++	+++	+	++	++	−	−
6	+++	+++	++	++	−	−	−
7	+++	++	++	−	−	−	−
8	+++	+++	−	−	−	−	−
9	+++	++	++	+	−	−	−
10	+++	+++	+++	++	+	−	−
Average	3.9	3.7	2.4	1.1	0.5	0.0	0.0

The judges were mindful of the effects of widely varying intensities of sapid substances on taste stimuli and tried not to be unduly critical or unfavorable toward those samples.

The Inhibiting Effect of Various Pressures of Homogenization Upon the Oxidized Flavor Development

Ten trials were conducted in which portions of the hot pasteurized milk containing 5 parts per million of added copper were homogenized at multiples of 500 pounds pressure between 0 and 3,000 pounds. The data obtained are presented in Table 2.

Although a 1,500-pound pressure inhibited oxidized flavor development in copper-contaminated milk in 60 per cent of the trials, a pressure of 2,500 pounds was necessary under the conditions of the experiment to effect complete inhibition. Lower pressures of 500 and 1,000 pounds, particularly the latter, were effective in lessening the rate of development in the majority of cases but did not stabilize entirely the flavor in respect to oxidized flavor.

The Effectiveness of Adequate Homogenization in Preventing the Development of Oxidized Flavor When Milk Contained Various Levels of Added Copper

Since a homogenization pressure of 2,500 pounds was found adequate in inhibiting the oxidized flavor development in milk containing 5 parts per million of added copper, a number of trials were performed at 0, 2,000, and 3,000 pounds pressure to determine how much copper might be added to milk before homogenization would become ineffective in stabilizing the flavor. Nine trials were carried out in which the amount of copper added to the milk varied from 3 to 15 parts per million, with 3 parts per million increments. The data obtained are given in Table 3.

Data in Table 3 show that a copper contamination of 6 parts per million was found to be slightly beyond the concentration at which normal homogenization pressures might be relied upon with assurance in inhibiting the development of the oxidized flavor. At this concentration of copper, a homogenization pressure of 3,000 pounds was found to be effective in stabilizing the milk flavor in seven of the nine trials, or 77.7 per cent. However, it is not improbable, that the milks which were obtained on different days may have varied in their susceptibilities toward oxidation, thus accounting for the slight and questionable oxidized flavors in the samples of trials 2 and 4 at 3,000 pounds pressure. On the other hand, the concentrations of copper in all series of this experiment were far beyond that normally present in naturally copper contaminated milk. The results obtained are of interest primarily in knowing how effective the homogenizer is in inhibiting the development of the oxidized flavor under very extreme conditions.

The Effectiveness of Homogenization in Inhibiting the Development of the Oxidized Flavor when the Milk was Copper Contaminated After Homogenization

In the preceding experiments the effectiveness of the homogenizer in inhibiting oxidative changes in milk contaminated with copper **prior to** homogenization was demonstrated. Trials were run likewise to

Table 3. The effectiveness of normal homogenization pressures in inhibiting the development of oxidized flavor when the milk contains various amounts of added copper.

Trial No.	Oxidized Flavor Development in Milk When the Copper Was Added at the Rate of (ppm.)														
	3			6			9			12			15		
	When Homogenized at (lbs. per sq. in.)														
	0	2000	3000	0	2000	3000	0	2000	3000	0	2000	3000	0	2000	3000
1..........	?	−	−	−	−	−	+++	+++	++	+++	+++	+++	+++	+++	+++
2..........	+++	−	?	+++	+++	+	+++	−	?	+++	+	?	+++	+++	+++
3..........	?	−	−	++	−	−	+++	+++	+++	+++	+++	+	+++	+++	+++
4..........	++	−	−	+++	+++	?	+++	+++	+++	+++	+++	+++	+++	+++	+++
5..........	?	−	−	++	++	−	+++	+++	++	++	+++	++	+++	+++	+++
6..........	?	−	−	++	?	−	+++	++	+	+++	+++	+++	+++	+++	+++
7..........	++	−	−	+++	++	−	+++	+++	+++	+++	+++	+++	+++	+++	+++
8..........	++	−	−	+++	?	−	+++	+++	+++	+++	+++	+++	+++	+++	+++
9..........	−	−	−	−	−	−	+++	++	++	+++	+++	+++	+++	+++	+++
Average....	1.9	0.0	0.1	2.8	1.8	0.3	4.0	3.3	3.1	3.9	3.7	3.3	4.0	4.0	4.0

determine the effectiveness of the homogenizer in inhibiting the development of the oxidized flavor when the copper was added to the milk **after** homogenization. Samples of milk to which was added 1.0, 2.5 and 5.0 parts per million of copper were homogenized at 3,000 pounds pressure. The data obtained are presented in Table 4.

Table 4. The effectiveness of the homogenizer in inhibiting the development of the oxidized flavor when the copper was added after homogenization.

Trial No.	The Oxidized Flavor Development in Milk Unhomogenized and Homogenized at 3000 Pounds Pressure When Various Amounts of Copper Were Added After Homogenization					
	Unhomogenized			Homogenized (3000 lbs.)		
	added copper (ppm.)			added copper (ppm.)		
	1.0	2.5	5.0	1.0	2.5	5.0
1	–	++	+	–	–	–
2	–	+	++	–	–	+++
3	–	++	+	–	–	++
4	++	+++	+++	–	–	+++
5	–	++	+++	–	–	++
6	+	++	+++	–	–	++
7	–	+++	+++	–	–	+++
8	–	–	++	–	–	++
9	–	++	++	–	–	++
10	–	++	++	–	–	–
11	+	+++	+++	–	–	+++
12	–	+++	+++	–	–	++
13	+	++	+++	–	–	+
14	++	+++	+++	–	–	+++
15	–	++	+++	–	–	+
16	+++	+++	+++	–	–	+
17	+	+++	+++	–	–	++
18	++	+++	+++	–	–	+
19	–	++	+++	–	–	+
20	++	+++	+++	–	–	–
21	++	+++	+++	–	–	–
22	+	++	+++	–	–	–
23	–	++	+++	–	–	–
Average	1.26	3.26	3.65	0.00	0.00	2.21

These values show that the homogenization inhibited completely the development of the oxidized flavor when copper was added to the milk at the rate of 1.0 and 2.5 parts per million following homogenization, but only retarded its development when 5.0 parts per million of copper was added. On the other hand, similar samples, but unhomogenized, showed flavor development in the majority of trials. A comparison of the data of Tables 3 and 4 shows that the oxidized flavor development in milk to which 6 parts per million of copper had been added **prior to** homogenization was practically inhibited by homogenizing at 3,000 pounds pressure, whereas similar homogenization pressures did not inhibit completely, although lessened its intensity, the oxidized flavor development when 5 parts per million of copper was added **after** homogenization. From these results, the effectiveness of the homogenizer in inhibiting the oxidized flavor development would seem to be greater when the milk were copper-contaminated prior to homogenization.

The Effectiveness of the Homogenizer in Preventing the Development of the Oxidized Flavor in Milk Having Various Fat Levels

From the same source of raw skimmed milk and cream, six lots of milk were standardized at 0.0, 2.0, 4.0, 6.0, 8.0, and 10.0 per cent of fat respectively. Following pasteurization, each lot was copper-contaminated at the rate of 5 parts per million, after which homogenization was carried out at 3,000 pounds pressure. The oxidized flavor development is shown in Table 5.

Table 5. The effectiveness of the homogenizer in inhibiting the development of the oxidized flavor when the milk contained low and high levels of fat.

Trial No.	Oxidized Flavor Development When the Milk Contained Fat as Follows (Per Cent)											
	0*		2		4		6		8		10	
	When Homogenized at (lbs. per sq. in.)											
	0	3000	0	3000	0	3000	0	3000	0	3000	0	3000
1	+++	+++	+	−	−	−	++	−	+	−	++	−
2	++	++	+	−	++	−	+	−	++	−	−	−
3	+++	+++	+++	−	++	−	++	−	++	−	++	−
4	+++	+++	+++	?	+++	+	+++	?	+++	−	+++	−
5	+++	+++	++	−	++	−	++	−	+	−	−	−
6	+++	+	++	−	+++	−	+++	−	+++	−	+++	−
Average	3.8	3.5	3.0	0.2	2.8	0.3	3.0	0.2	3.0	0.0	2.3	0.0

*The skimmed milk was centrifugally produced and contained approximately 0.02 per cent fat by the Babcock Test. The flavor developed is here recorded as oxidized, but it should be mentioned that the flavor developed was not the "pure" oxidized flavor frequently observed in whole milk, although similar in many respects.

Observations on these studies indicate that the effectiveness of the homogenizer in inhibiting the oxidized flavor development is as great with milk of 2.0 per cent fat as with milk of 10.0 per cent fat. However, as will be pointed out later, the flavor is stabilized against oxidized flavor developments by homogenization only when appreciable quantities of fat are present. A pressure of 3,000 pounds was sufficient to inhibit the development of the off flavor in the majority of the trials. In only one case was the oxidized flavor actually detected in the homogenized samples and in only two other cases was the presence of this flavor a question. All of these discrepancies appeared in trial 4. The lack of complete agreement with the other five trials may permit the results of this trial to be regarded with suspicion.

Homogenization of skimmed milk did not inhibit the development of an intense "off" flavor in the skimmed product. This flavor resembled closely but was unlike the "pure" oxidized flavor noted in oxidized flavored whole milk. However, this developed off flavor was recorded as oxidized flavor in Table 5.

The Effectiveness of the Homogenizer in Preventing the Development of the Oxidized Flavor in Milk Having Various Added Amounts of Serum Solids

Four trials were conducted to determine the effectiveness of homogenization in inhibiting the development of the oxidized flavor when various amounts of milk solids-not-fat were added to the milk. High quality spray-dried skimmed milk powder, at rates of 1.0, 2.0, 3.0 and 4.0 per cent respectively was dissolved in the milk prior to pasteurization. Copper was added at the rate of 5 parts per million before homogenization which was carried out at 3,000 pounds. The data are presented in Table 6.

Table 6. The effectiveness of the homogenizer in inhibiting the development of the oxidized flavor when various amounts of serum solids were added to the milk prior to homogenization.

Trial No.	The Oxidized Flavor Development When the Milk Contained Added Serum Solids as Follows (Per Cent)									
	0		1		2		3		4	
	When Homogenized at (lbs. per sq. in.)									
	0	3000	0	3000	0	3000	0	3000	0	3000
1	+++	–	+++	–	+	–	+	–	–	–
2	+++	–	++	–	–	–	–	–	–	–
3	++	–	++	–	+++	–	+	–	–	–
4	+++	–	+++	–	+++	–	+++	–	+++	–
Average	3.8	0.0	3.5	0.0	2.5	0.0	2.0	0.0	1.0	0.0

The results indicate that the homogenizer's ability to prevent oxidized flavors under conditions of this experiment was not affected by the addition of skimmed milk powder. The oxidized flavor was not detected in any of the homogenized samples, but was observed in varying intensities in many of the unhomogenized samples. However, it was noted that as the amount of added solids increased there was a decided decrease in intensity of oxidized flavors in many of the control samples, while in others the oxidized flavor was not detected. This was likely due, in part at least, to a salty flavor which was imparted to the milk by the addition of the 3.0 and of the 4.0 per cent of dry skimmed milk powder, which may have obscured partially any oxidized flavor. Despite the additions of larger amounts of powder, the oxidized flavor was very strong in all of the unhomogenized samples of trial 4, which were held 72 hours before scoring.

Discussion and Summary

The chief flavor defects of adequately refrigerated held milk are the rancid and the oxidized flavors. Rancidity is current to raw milk while oxidized flavors are more common to pasteurized winter milk.

Because of the accelerating effect of homogenization on hydrolysis, resulting in the development of rancidity, homogenized milk must be pasteurized before or immediately after processing. Furthermore, homogenized milk must be clarified to prevent sedimentation. Under proper refrigeration to prevent bacterial growth, milk thus both pasteurized and clarified should be expected to possess superior keeping qualities, especially so far as off flavors are concerned. However, under proper storage, some milks have been observed to develop an objectionable oxidized flavor within 24 to 48 hours time. Several investigators have noted that homogenization retards or prevents the development of this off-flavor.

This investigation has been carried out to determine the effectiveness of the homogenizer under certain conditions to stabilize the clean, sweet, pleasant flavor of milk.

Data are presented showing that pressures of 1,500 pounds have a marked effect in stabilizing the flavor of copper-contaminated milk. Pressures of 2,000 pounds were more effective, but pressures of 2,500 and 3,000 were sufficient to inhibit the development of the oxidized flavor when the copper was added at the rate of 5.0 p.p.m. **prior to** homogenization. However, 3,000 pounds pressure homogenization was practically ineffective in its inhibition of the flavor development when the amount of copper added to the milk prior to processing exceeded 6.0 p.p.m.

Although homogenization at 3,000 pounds pressure inhibited oxidized flavor development in milk contaminated with 2.5 p.p.m. **after** processing, this pressure was ineffective when 5.0 p.p.m. of copper were similarly added. The homogenizer was found, therefore, to be more effective in stabilizing the flavor of milk if the milk were contaminated with copper before homogenization.

Homogenization stabilized the flavor of copper-contaminated milk containing from 2.0 to 10.0 per cent fat. However, the process was ineffective in stabilizing the flavor when fat was present in inappreciable quantities, as in skimmed milk.

The addition of serum solids from 1.0 to 4.0 per cent did not lessen the effectiveness of the homogenizer in inhibiting the development of the oxidized flavor.

The milk used in these studies was in most trials copper-contaminated far beyond that normally encountered in handling and processing milk in contact with exposed copper. Homogenization, effective against oxidative flavor developments under many of these extreme conditions, would appear to be effective in stabilizing flavors under practical plant conditions. Data are not presented, but observations made on many samples of commercial homogenized milk permits the authors to conclude that such milk properly produced and adequately refrigerated away from excessive light is not prone to "off" flavor developments.

1. Babcock, C. J.
   1934. The Effect of Homogenization on Certain Characteristics of Milk.
   U. S. Dept. of Agr. Tech. Bul. 438.

2. Doan, F. J. and Minster, C. H.
1933. The Homogenization of Milk and Cream.
Pa. Agr. Exp. Sta. Bul. 287.

3. Dorner, W. and Widmer, A.
1931. Rancissement du Lait par l' Homogeneisation.
Le Lait, **11,** 545-567.

4. Halloran, C. P. and Trout, G. M.
1932. Effect of Viscolization on Some of the Physical Properties of Milk.
Abs. Proc. Am. Dairy Sci. Ass'n., 27th Ann. Meeting.

5. Holm, G. E., Greenbank, G. R. and Deysher, E. F.
1925. The Effect of Homogenization, Condensation and Variations in the Fat Content of Milk Upon the Keeping Quality of Its Milk Powder.
Jour. Dairy Sci. **8,** 515.

6. Hood, E. G. and White, A. H.
1934. Homogenization of Market Milk.
Can. Dept. of Agr. Mimeograph No. 25.

7. Ross, H. E.
1937. Homogenization as a Preventive of Oxidized Flavor.
Milk Plant Monthly **26**:4, 5.

8. Thurston, L. M., Brown, W. C., and Dustman, R. B.
1936. The Effects of Homogenization, Agitation and Freezing of Milk on its Subsequent Susceptibility to Oxidized Flavor Development.
Jour. Dairy Sci. **19,** 671.

9. Tracy, P. H., Ramsey, R. J., and Ruehe, H. A.
1933. Certain Biological Factors Related to Tallowiness in Milk and Cream.
Ill. Agr. Exp. Sta. Bul. 389.

10. Trout, G. M. and Halloran, C. P.
1932. Sediment in Homogenized Milk.
Mich. Agr. Exp. Sta. Quar. Bul. **15,** 107.

11. Trout, G. M., Halloran, C. P., and Gould I.
1935. The Effect of Homogenization on Some of the Physical and Chemical Properties of Milk.
Mich. Agr. Exp. Sta. Bul. 145.

12. Trout, G. M.
1937. Off Flavors in Raw and Pasteurized Milk.
Lab. Proc. Int. Ass'n Milk Dealers. p. 131-142.

OBSERVATIONS ON CONTROL OF CANKERWORM BY SPRAYS*

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For several seasons experimental work with different spray combinations has been conducted to determine the efficiency of various insecticides for the control of the spring cankerworm *(Paleacrita vernata)* and the fall cankerworm *(Alsophila pometaria)* on elms along roadsides and on ornamental plantings.

Fig. 1. A satisfactory method of applying spray material on shade trees.

The fall cankerworm has not been a problem where the trees receive a 4 per cent application of dormant oil spray before growth starts in the spring. This spray was recommended primarily to control the European elm scale *(Gossyparia ulmi)* which is often a problem on trees in ornamental plantings. Also it has been noted that where trees so sprayed are banded with either cotton or Tanglefoot immediately after the spray is applied that the trees are not attacked by spring cankerworm.

*Sprays applied by Frank Parmelee and G. A. Bradley.

TABLE SHOWING PROPORTIONS OF SPRAY INGREDIENTS TO 100 GALLONS OF WATER USED IN CONTROL OF CANKERWORMS

Spray	Time Application	Observations
Lead arsenate 3 lb. Summer oil 3 qts. Pyrethrum Soap. 1½ pts.	27 May, 1936.	Larvae dropped immediately. 100 per cent kill. Bright, clear day.
Lead arsenate 3 lb. Summer oil 3 qts. Nicotine sulphate 1½ pts.	27 May, 1936.	Only a few larvae dropped. Kill was gradual but satisfactory.
Lethane 1:300 Lethane spreader 1:300 Lead arsenate 3 lb.	27 May, 1936.	Did not kill larvae. Trees were completely defoliated as were checks.
Lead arsenate 3 lb. Orthex 1 pt.	20 May, 1937.	Control effective. Trees lost but little foliage.
Cube 3 lb. Rosin residue 3 lb.	5 June, 1937.	No live larvae were found at end of 72 hours. Numerous on checks.
Derris 4 lb. Rosin residue 3 lb.	5 June, 1937.	No live larvae were found at end of 72 hours. Numerous on checks.
Nicotine sulphate 1½ pts. Summer oil 3 qts.	26 May, 1938.	Kill very slow. Larvae remained on the foliage for several days without feeding, but eventually died.
Soybean flour 3 lb. Soybean oil 1 qt. Nicotine sulphate 1½ pts.	26 May, 1938.	Similar to nicotine sulphate and summer oil, but much more rapid and pronounced.
Diamond paraffin 2 qts. Red oil 1 qt. Free nicotine (50%) ½ pt.	26 May, 1938.	Good control. Kill slower than pyrethrum sprays or calcium arsenate.
Calcium arsenate 3 lb. Soybean oil 1 qt.	27 May, 1938.	Larvae hung suspended from silken threads or clustered on the bark. 72 hours after spray was applied feeding completely ceased.
Lead arsenate 3 lb. Soybean oil 1 qt.	27 May, 1938.	Larvae had ceased to feed but were more active at end of 72 hours than those sprayed with calcium arsenate. Suspended from foliage on threads. Good control.
Lead arsenate 3 lb. Diamond Paraffin 1 qt.	27 May, 1938.	Good control.

Trees sprayed with lead arsenate, 3 pounds; summer oil, 1 quart; water 100 gallons, when the leaves are half-grown, are not injured by either species of cankerworm. Where the application is delayed until the trees are in full foliage, or until the worms are more than half-grown, the loss of foliage is decidedly greater and the worms are more difficult to kill. The above sprays were applied by a power spray rig giving 600 to 800 pounds pressure at the nozzle.

None of the 12 spray combinations caused spray injury to the foliage. The spray was applied in most instances to elm, though in many stands sycamore, basswood, hawthorn, maple, and boxelder were inter-planted.

For general purposes, lead arsenate with an oil spreader-sticker seems satisfactory. The larvae may hang from their silken threads for a week or more, but along roadsides or in out-of-the-way places this will not be found objectionable. Around houses or lawns, either the pyrethrum, derris or cube combinations are suggested since the larvae die almost immediately and no harmful residues need be considered. Where contact sprays are applied, thorough coverage is necessary because only the larvae hit are killed.

Cankerworms migrate slowly from one tree to another and an infestation builds up gradually over a long period of time. They are never a problem in well-sprayed orchards or where an effort is made to keep the population down. One thorough application under average conditions will hold cankerworms in check for several years.

MASTITIS CONTROL PROGRAM PROVED SUCCESSFUL

Program Carried on in Upper Peninsula Sub-Station Dairy Herd

RUSSELL E. HORWOOD AND C. S. BRYAN
SECTIONS OF DAIRY HUSBANDRY AND BACTERIOLOGY

Mastitis is rapidly becoming recognized as an important disease in dairy cattle, and methods of controlling its spread and elimination are being studied by many dairymen. A program with this thought in mind was started in the Chatham Sub-Station dairy herd in September 1934.

Prior to 1932 the major portion of the milking herd was made up of cows which were relatively heavy milkers. A number of these cows had large pendulous udders which were easily injured. Udder troubles were a continuous problem and resulted in loss of quarters, deficient quarters, and flaky or garget milk, all of which now are known as evidence of mastitis. At this time a large number of daughters of a bull which had transmitted udders that were somewhat smaller and more strongly attached than their dams came into production. This made it possible to eliminate many of the older cows. It left a much younger herd with very desirable udders.

During September 1934, samples of milk were taken and tested for

streptococcic mastitis, employing the microscopic test. Three cows reacted to this test and were eliminated from the herd. Only one of these cows had ever shown evidence of the disease. On the next test, conducted during December, one cow reacted, although she showed no evidence of udder trouble. This was a heifer that freshened after the three positive reactors had been eliminated from the herd. The same animal proved to be the only reactor in the January test. Following this test this cow was given a lacto-vaccine treatment at weekly intervals for four weeks. The lacto-vaccine was made up by mixing 30 cc. of milk from the positive cow with one-third cc. of a one per cent solution of brilliant green. This was injected subcutaneously. This cow was negative on the following test and has remained so ever since.

All the cows in the herd remained negative to mastitis until the December test in 1935. On this test an eight-year-old cow which was practically dry was positive. Another test was conducted on this cow while she was dry by obtaining milk serum from each quarter. She reacted positively to the test also. She was then given the lacto-vaccine treatment as previously outlined. She was tested in February 1936, after freshening and was found negative. She remained negative until August of that year at which time she was sold for production and was still producing normally in December 1937, when the latest report was obtained on her. The herd which has numbered from 15 to 22 cows has continued negative to the mastitis test since December 1935. Good sanitary practices were followed in the herd during this time. The positive animals were placed in the end stanchions or on the opposite side of the barn and milked last. The herd is free from light or deficient quarters and udder trouble at the present time. Monthly tests are now being conducted.

PRODUCING AND FINISHING BEEF CALVES

G. A. BROWN, G. A. BRANAMAN, AND G. J. PROPP
SECTION OF ANIMAL HUSBANDRY

During recent years, Michigan has been particularly fortunate in having a large crop of hay each year and also very liberal yields of grain. This condition has resulted in a marked increase of interest in finishing cattle for beef production.

Several thousand cattle are purchased annually from the western grazing sections to be finished on Michigan farms. Liberal supplies of feed and rather limited supplies of feeding cattle during recent years have resulted in many feeders being forced to pay prices for their feeding animals that practically eliminated any possibility of a profit in the operation. This, together with the increased acreage of pastures and leguminous crops has resulted in a wide-spread interest in the keeping of breeding herds of cows for producing beef calves. The work reported here was undertaken to answer questions which arise regarding the cost of keeping beef breeding cows a year and the possibility of a profit when such cows are kept solely to produce beef calves.

The following figures represent one full year's work on the handling of 10 cows and the finishing of their calves for beef production. The cows were not nursing during the winter months, the calves being born in April and May.

Feeds Fed and Cost of Maintaining Each Cow

Feed	Amount	Cost	Value
Corn silage	3,479 lbs.	$4.00 per ton	$6.96
Alfalfa hay	640 lbs.	10.00 per ton	3.20
Cottonseed meal	16 lbs.	1.50 per cwt.	.24
Oat straw	1,739 lbs.	5.00 per ton	4.34
Pasture	....	....	10.00
Annual feed and pasture cost per cow	....	....	$24.74

One-half the calves, designated as the "full-fed" group, were creep-fed, starting when they were approximately 3 months of age, and were sold at 11 months old when they were fat enough to grade as choice.

The "limited-fed" group of calves were not given any grain while on pasture, and were fed largely on silage and hay for several months after the close of the grazing season with the object of producing

Weights and Gains of Calves

	Full-fed Group	Limited-fed Group
Age when marketed	332 days	463 days
Weight when marketed	726 lbs.	860 lbs.
Gain per calf	656 lbs.	790 lbs.
Average daily gain	1.98 lbs.	1.7 lbs.

Feeds fed per calf	Amount	Cost	Amount	Cost
Cracked corn	1,295.19 lbs.	$17.19	1,040 lbs.	$13.00
Cottonseed meal	188.8 lbs.	2.83	418 lbs.	6.27
Corn silage	1,442.5 lbs.	2.89	4,539 lbs.	9.07
Alfalfa hay	295.7 lbs.	1.48	693 lbs.	3.46
Cost of feed per calf	....	$23.39	....	$31.80
Cost of feed per cow	....	24.74	....	24.74
Total feed cost per cow and calf	....	$48.13	....	$56.54
Feed cost per 100 lbs. beef produced	....	6.66	....	6.57

Feed prices: Cracked corn—$1.25 per cwt.; cottonseed meal—$30 per ton; corn silage—$4 per ton; alfalfa hay—$10 per ton.

growth rather than finish. They were then full-fed until they were fat enough to grade choice.

It should be noted from the above that the feed and pasture cost of keeping a cow for one year to produce a calf was $24.74 which would represent the feed cost of the calf where a 100 per cent calf crop was raised. If but 8 calves were raised from 10 cows, this cost would be increased by $6.18 per calf or the total cost would be $30.92 per calf.

Many feeders are paying prices much higher than this for 400-pound feeding calves delivered to them during the fall. In performance in the feedlot the locally-reared calf is more satisfactory than the calf which must undergo the hardships of a long railroad journey, exposure to disease enroute and also suffer the heavy shrinkage incident to shipping.

One-half the calves from these 10 cows were full-fed from the time they were three months of age and marketed during the early spring months at approximately 11 months of age. The total feed cost of these calves at that age was $48.13 per head or $6.66 per hundredweight. The limited-fed group of calves grew slower than the full-fed group, consumed more roughage and were placed on the market in late August and September when 15 to 16 months of age, weighing at that time about 140 pounds more than did the full-fed group when marketed. The total feed cost of the limited-fed calves was $56.54 per head or $6.57 per hundredweight.

Feed costs represent approximately 80 per cent of total costs of beef production. On this basis and raising an 80 per cent calf crop, the cost per calf would be $67.88 in the full-fed group, and $78.40 in the limited-fed group, or $9.35 and $9.11 per hundredweight of beef produced in the respective groups.

The difference in cost per hundredweight between the two methods of feeding was not significant. There are, however, three factors which should be studied carefully before deciding which method to follow. These are: (1) The comparative amounts of roughages and concentrates available for feeding; (2) the average market prices for finished cattle in the spring and fall months; and (3) the sex of the calves. Heifer calves finish more rapidly than steers and should, as a rule, be ready for the spring market. Steer calves, on the other hand, finish slower and it is often desirable to carry them for the fall market when there is usually a scarcity of the better grades of finished cattle.

The maintenance of a herd of breeding cows for beef production eliminates much of the speculative element involved in the purchase of feeding cattle, enables the operator to utilize more pasture and larger quantities of roughage and, when good sires are used, to produce a superior beef animal.

THE SHEEP FLOCK

LEONARD H. BLAKESLEE, J. G. WELLS, JR., AND G. A. BROWN
SECTION OF ANIMAL HUSBANDRY AND UPPER PENINSULA EXPERIMENT STATION

In commercial sheep production, approximately 75 per cent of the yearly income is derived from the sale of lambs, and 25 per cent from the sale of wool. When fine wool sheep are raised, the wool often represents a greater portion of the income. On the other hand, when the medium wool breeds of mutton sheep are raised, the wool may represent only 10 to 15 per cent of the yearly income. The comparative market price of wool and lambs, marketing facilities, and type of farming determine the breed of sheep that is best adapted to a certain locality. Of the several breeds of sheep, the strictly mutton breeds usually produce a fast-growing, well-finished lamb available for early market; but, the breeding flock produces rather light fleeces, while the fine-wool breeds of sheep produce slower-growing lambs and the ewes shear heavy fleeces.

Returns in commercial sheep production are increased when one can combine to some degree the mutton qualities of the medium and coarse wool breeds with the quality and weight of fleece of the fine wool breeds.

A flock of ewes has been maintained at the Chatham Sub-Station since 1913. This flock, which until 1928 consisted of purebred and grade Hampshire, Shropshire, and Rambouillet ewes, has provided some interesting data on the adaptability of these breeds to that locality and the conditions existing there. Wintered entirely on roughage grown on the farm, and pastured during the summer on rough cut-over pasture until marketing time in the fall, the Hampshires have excelled both the Rambouillets and Shropshires in the production of fast-growing, market-topping lambs sold off grass. The Hampshires, however, have sheared light fleeces, many of which were of clothing length. The Shropshires sheared about the same amount of wool as the Hampshires, but their lambs failed to make sufficient growth to be marketed off grass. The Rambouillet lambs lacked sufficient finish and weight to sell satisfactorily off grass. The heavy covering of wool over the face of the Shropshire and Rambouillet was a distinct handicap to these breeds when grazing on rough cut-over pasture land.

The Rambouillet produced fleeces averaging 8.3 pounds in weight, as compared with an average of 6.3 pounds for the Shropshire and Hampshire. Practically all the Rambouillet and many of the Hampshire fleeces were graded as clothing, and sold at a discount as compared with wool of staple length.

The flock at Chatham is largely on a commercial basis, there being very little call for purebred sires. The lamb crop with the exception of ewes held for replacements is shipped to Chicago in September or early October each year.

Cross-breeding was inaugurated in the flock at Chatham in 1928, with the hope of producing individuals with the meat qualities of the Hampshires and capable of shearing a 10-pound fleece of staple length and grade. The purebred Hampshire flock, due to its excellent mutton-producing qualities, was maintained in order to furnish a check on the results obtained.

The grade Hampshire ewes were bred to a heavy-shearing, long-staple, purebred Black Top Delaine ram. The Rambouillet ewes were bred to a heavy-shearing, purebred Lincoln ram. When the ½-blood ewes saved for breeding were mature those sired by the Black Top Delaine ram were mated to the Lincoln ram, and the ewes sired by the Lincoln ram were mated to the Black Top Delaine ram.

Table 1. Number of ewes, lambs produced, and weights of lambs at weaning.

	Number of Ewes	Lambs Dropped Per 100 Ewes	Lambs Weaned Per 100 Ewes	Weight of Lambs at Weaning Time Pounds
Hampshire Ewes Hampshire Sire	203	170	114	72.5
½-Blood Lincoln Ewes Black Top Sire	121	145	111	68.54
½-Blood Black Top Ewes Lincoln Sire	116	167	110	75.56

NOTE: The difference between lambs dropped and lambs weaned represents losses at lambing time, and while on pasture. Many of the pasture losses were due to predators which constitute a serious problem at Chatham.

As noted in Table 1, there was little difference in the number of lambs produced by the Hampshire ewes bred to a Hampshire sire and the ½-blood Black Top ewes bred to a Lincoln sire. The ½-blood Lincoln ewes bred to a Black Top sire gave birth to fewer lambs than either of the other two flocks. The number of lambs weaned per 100 ewes was practically the same for the three flocks. In weight per lamb at weaning time, the lambs sired by the Lincoln ram were decidedly the heaviest, followed by the Hampshire lambs, with the lambs sired by the Black Top ram somewhat lighter. The average weight of the lambs from the two cross-bred flocks was approximately the same as the weight of the Hampshire lambs.

As the figures indicate, there is a substantial increase in the wool production of the cross-breds over the present Hampshire ewes and the original grade Hampshire and grade Rambouillet ewes, upon which the crosses were made. The Hampshire ewes sheared an average of 6.5 pounds per fleece, or approximately the same as the original ewes. The cross-bred ewes sheared an average of 9.65 pounds, which is 1.35 pounds more than the original Rambouillet flock and 3.35 pounds more than the Hampshire foundation flock.. As shown in Table 2, 18 per cent of the Hampshire fleeces graded during the four years (1934 to 1937, inclusive) were of clothing length, while only 3.21 per cent of

Table 2. Number of sheep shorn, average weight of fleeces, and grade of wool produced.

	Hampshire Ewes		Cross-bred Ewes	
Number of ewes	233		280	
Average weight of fleece	6.5 lbs.		9.65 lbs.	
Market grade of fleeces	No.	Per Cent	No.	Per Cent
Fine combing	1	.43	17	6.07
½-blood combing	14	6.00	64	22.86
⅜-blood combing	85	36.48	68	24.28
¼-blood combing	81	34.76	84	30.
Low ¼-blood combing	9	3.86	33	11.78
Braid	1	.43	5	1.78
Clothing	42	18.	9	3.21

the cross-bred fleeces were of clothing length. It should be noted that 71.5 per cent of the Hampshire fleeces graded either ⅜-blood or ¼-blood staple, while 77 per cent of the cross-bred fleeces were ½-blood, ⅜-blood, or ¼-blood staple. Low ¼-blood combing represents 11.78 per cent of the cross-bred fleeces graded.

Summary

1. There has been no appreciable difference in weight at weaning time between the cross-bred and the Hampshire lambs.

2. When each cross is considered separately, the lambs sired by the Lincoln ram out-weighed the Hampshire lambs, while the lambs sired by the Black Top ram weighed less than the Hampshires at weaning time.

3. The Hampshire flock produced 2.6 pounds more lamb per ewe at weaning time owing to the fact that they dropped a larger percentage of lambs and also raised a larger percentage than the other two flocks.

4. The cross-bred flocks produced 3.35 pounds more wool per head than did the Hampshire flock.

5. Approximately 97 per cent of the cross-bred fleeces and 82 per cent of the Hampshire fleeces were of combing length.

PRICES OF LIVESTOCK AND LIVESTOCK PRODUCTS IN MICHIGAN, 1929-'37

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The purpose of this article is to present and briefly analyze the farm prices of livestock and livestock products from 1929 to 1937 and to bring up to date previous reports of farm prices and farm costs.* The indices of the prices of livestock and livestock products are compared in charts with the index of Michigan farm costs which is calculated by combining and weighting the following indices—prices paid by farmers for commodities bought for production (466), Michigan farm taxes (140), Michigan farm wages (150), and Michigan farm interest payments (85).

Table 1. Prices paid to producers for cattle in Michigan.*

(dollars per 100 pounds)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Wtd. Ave.
1910-14	5.12	5.02	5.36	5.48	5.66	5.60	5.50	5.42	5.40	5.26	5.08	5.12	5.32
1924-28	6.52	6.66	6.82	7.18	7.22	7.30	7.38	7.10	7.28	7.06	7.14	7.14	7.06
1929	9.10	8.90	9.00	9.50	9.80	9.90	10.00	9.50	8.90	9.10	8.60	8.60	9.21
1930	8.80	8.80	8.80	8.40	8.10	8.00	6.50	6.40	6.10	6.10	5.90	5.80	7.28
1931	5.90	5.80	5.70	5.70	5.50	5.30	5.00	4.90	4.90	4.70	4.40	4.30	5.16
1932	4.20	4.10	3.90	4.10	3.80	3.70	4.20	4.20	4.20	3.80	3.60	3.40	3.93
1933	3.40	3.40	3.40	3.40	3.95	4.00	3.90	3.70	3.70	3.55	3.30	3.00	3.54
1934	3.55	3.55	3.65	3.70	3.85	3.75	3.75	3.55	3.80	3.80	3.80	3.35	3.63
1935	4.15	5.10	6.20	6.40	6.90	6.60	6.30	6.10	6.20	6.30	6.20	6.20	6.03
1936	6.20	6.10	5.80	6.20	6.20	6.30	6.00	6.10	6.20	6.10	5.90	6.30	6.13
1937	6.40	6.50	6.60	7.00	7.30	7.60	7.40	8.00	8.10	7.30	6.70	6.20	7.07
1938	6.20	5.80	6.30	6.30	6.60	6.70							
1939													

*To supplement Table 36, p. 61, Mich. Agr. Exp. Sta. Tech. Bul. 139.

The primary factors affecting the prices of livestock and their products during 1929-'37 were (1) the decline and rise of the general price level, (2) the decrease and increase in consumer purchasing power, and (3) the position in the purchasing power cycle of the specific class of livestock. The decline in the general price level from 1929 to 1932 resulted in farm prices falling drastically, since farmers received a smaller proportion of the prices which consumers paid because the costs of moving the farm products from the farm to the consumer

*Michigan Farm Prices and Costs, 1910-1934, Mich. Agr. Exp. Sta. Tech. Bul. 139, June, 1934; Farm Prices and Costs in Michigan, Mich. Agr. Exp. Sta. Quar. Bul. 20: 2, Nov., 1937; Prices of Cash and Feed Crops in Michigan, 1929-37, Mich. Agr. Exp. Sta. Supplement to Quar. Bul. 20: 4, May, 1938.

Table 2. Index numbers of prices paid to producers for cattle in Michigan.*

(1910-'14 = 100)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Wtd. Ave.
1910-14	96	95	101	103	106	105	104	102	102	99	96	96	100
1924-28	122	125	128	137	138	137	139	134	137	133	134	134	135
1929	171	167	169	179	184	186	188	179	167	171	162	162	173
1930	165	165	165	158	152	150	122	120	115	115	111	109	137
1931	111	109	107	107	103	100	94	92	92	88	83	81	97
1932	79	77	73	77	71	70	79	79	79	71	68	64	74
1933	64	64	64	64	74	75	73	70	70	67	62	56	67
1934	67	67	69	70	72	70	70	67	71	71	71	63	68
1935	78	96	117	120	130	124	118	115	117	118	117	117	113
1936	117	115	109	117	117	118	113	115	117	115	111	118	115
1937	120	122	124	132	137	143	139	150	152	137	126	117	133
1938	117	109	118	118	124	126							
1939													

*To supplement Table 37, p. 61, Mich. Agr. Exp. Sta. Tech. Bul. 139.

declined less rapidly than did retail prices. During the rise of the general price level from 1933 to 1937, farmers received a larger proportion of the higher retail prices because distributing costs rose slowly.

The reduction in purchasing power or money in the hands of the city consumers during 1929-'32 was a contributing factor to lower farm prices. Wages, salaries and other incomes of city people declined while the production of farm products remained at about the same level. Consequently, the consumers could buy the supplies from the farms only at lower levels. If farm production had been contracted, consumers would have purchased less food at higher retail prices. The expansion of buying power from 1933 to 1937 aided in stimulating the rise in farm prices.

The production of each class of livestock tends to move in a cycle. Short supplies and high prices stimulate expansion. Large supplies and

Table 3. Prices paid to producers for calves in Michigan.*

(dollars per 100 pounds)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Wtd. Ave.
1910-14	7.52	7.50	7.52	7.10	6.92	7.04	7.18	7.38	7.68	7.76	7.46	7.48	7.35
1924-28	11.88	12.42	12.24	11.80	11.16	11.20	11.46	11.76	12.22	12.94	12.12	12.14	11.92
1929	15.10	15.30	14.70	14.20	14.00	13.90	14.50	14.50	14.40	14.70	13.90	14.10	14.41
1930	14.20	13.80	13.20	12.40	10.50	10.40	10.40	10.50	10.90	10.90	10.30	10.00	11.30
1931	10.10	9.40	9.10	8.60	8.00	7.60	7.50	7.80	8.30	8.40	7.10	6.50	8.20
1932	6.70	7.00	6.80	5.90	5.00	5.20	5.70	5.80	5.90	5.30	5.10	4.70	5.73
1933	4.85	6.00	5.40	4.80	4.90	4.90	5.30	5.70	6.20	6.10	5.40	5.00	5.30
1934	5.30	6.30	5.70	5.50	5.50	5.10	5.20	5.80	6.31	6.50	5.80	5.90	5.64
1935	7.20	8.00	8.60	8.70	8.10	8.30	8.20	9.00	9.80	9.80	9.90	9.90	8.77
1936	10.40	10.60	9.10	8.90	8.80	8.80	8.60	8.80	9.30	9.40	9.20	9.50	9.28
1937	11.10	9.90	9.60	9.40	9.00	9.20	9.40	10.60	11.00	10.70	10.00	10.00	9.90
1938	10.40	10.20	10.10	9.70	8.60	8.70							
1939													

*To supplement Table 39, p. 64, Mich. Agr. Exp. Sta. Tech. Bul. 139.

Table 4. Index numbers of prices paid to producers for calves in Michigan.*

(1910-'14 = 100)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Wtd. Ave.
1910-14	102	102	102	97	94	96	98	100	104	106	101	102	100
1924-28	162	169	166	160	152	152	156	160	171	176	165	165	162
1929	205	207	199	192	179	188	196	196	195	199	188	191	196
1930	192	187	179	168	142	141	141	142	148	148	140	136	154
1931	137	127	123	116	108	103	102	106	112	114	96	88	112
1932	91	95	92	80	68	70	77	79	80	72	69	64	78
1933	66	81	73	65	66	66	72	77	84	83	73	68	72
1934	72	85	77	74	74	69	70	79	85	88	79	80	77
1935	98	108	117	118	110	112	111	122	133	133	134	134	119
1936	141	144	123	120	119	119	117	119	126	127	125	129	126
1937	150	134	130	127	121	124	127	143	149	146	136	136	135
1938	141	139	137	131	117	118							
1939													

*To supplement Table 40, p. 64, Mich. Agr. Exp. Sta. Tech. Bul. 139.

low prices result in contraction. A satisfactory method of measuring the position of the purchasing power cycle of each class of livestock is to compare the prices of the livestock with the prices of items which farmers buy. For example, if the farmers can buy many commodities with beef cattle or sheep, they will expand their herds or flocks. If beef and mutton buy fewer commodities, the size of the herds and flocks will be reduced. A purchasing power index of the prices of livestock is computed by dividing the index of the value per head (as of January 1) by the index of wholesale prices (average of December and January).

The livestock producer, like the grower of cash crops, is concerned not only with the trend in prices of the products but also with the changes in farm costs. The position of the livestock farmer was somewhat different from the crop farmer during 1929-'32 since one of the principal costs of livestock is feed which declined in price more than

Table 5. Prices paid to producers for hogs in Michigan.*

(dollars per 100 pounds)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Wtd. Ave.
1910-14	7.16	7.24	7.66	7.80	7.50	7.34	7.32	7.74	7.90	7.54	6.84	6.58	7.32
1924-28	9.22	9.52	9.86	9.78	9.84	9.66	10.12	10.80	11.00	10.88	9.84	9.42	9.92
1929	8.50	9.20	10.50	10.60	10.60	10.30	10.70	11.10	10.10	9.60	8.70	8.80	9.69
1930	9.00	9.70	9.90	9.70	9.40	9.40	8.80	8.90	9.70	9.00	8.60	7.60	9.09
1931	7.80	7.20	7.20	7.30	6.80	5.90	6.50	6.70	6.00	5.10	4.60	4.00	6.14
1932	3.90	3.80	4.10	3.90	3.30	3.10	4.50	4.40	4.00	3.60	3.20	2.95	3.63
1933	2.95	3.30	3.40	3.30	3.85	4.10	4.20	4.05	4.00	4.40	3.75	3.05	3.63
1934	3.25	4.20	4.15	3.70	3.40	3.55	4.30	4.75	6.10	5.50	5.10	5.20	4.44
1935	7.10	7.50	8.50	8.45	8.50	8.90	8.90	10.70	10.80	10.20	8.80	9.00	8.82
1936	9.20	9.60	9.80	9.70	9.00	9.40	9.70	10.30	10.10	9.50	8.90	9.20	9.44
1937	9.90	9.60	9.50	9.30	9.80	10.40	11.20	12.20	11.30	10.30	8.40	7.70	9.68
1938	7.90	8.00	8.80	8.10	7.70	8.40							
1939													

*To supplement Table 41, p. 67, Mich. Agr. Exp. Sta. Tech. Bul. 139.

Table 6. Index numbers of prices paid to producers for hogs in Michigan.*

(1910-'14 = 100)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Wtd. Ave.
1910-14	98	99	105	107	102	100	100	106	108	103	94	90	100
1924-28	126	130	135	134	134	132	138	148	150	148	135	128	136
1929	116	126	143	145	141	141	146	151	138	131	119	120	132
1930	123	132	135	132	128	128	120	122	132	123	118	104	124
1931	107	99	99	100	93	81	89	92	82	70	63	55	84
1932	54	53	57	54	45	42	62	61	55	49	44	40	50
1933	40	45	46	45	53	57	58	56	55	61	51	41	50
1934	44	58	57	51	47	48	59	65	84	75	70	71	61
1935	97	103	116	115	116	122	122	146	147	139	120	123	120
1936	126	131	134	132	123	128	132	141	138	130	122	126	129
1937	135	131	130	127	133	141	153	166	154	141	115	105	132
1938	108	109	120	110	105	115							
1939													

*To supplement Table 42, p. 67, Mich. Agr. Exp. Sta. Tech. Bul. 139.

livestock during that period. Insofar as livestock farmers purchased cheap feeds, they were affected less by declining prices than were the farmers who raised crops for feeding or for cash sale. However, livestock farmers were affected unfavorably by the many rigid cost items which declined slowly during deflation. The rapid rise in the prices of feed crops following the crop reduction programs and the drouths of 1934 and 1936 resulted in very unfavorable feed-product price ratios. Since the recovery of prices of livestock products was also retarded by the slow expansion of consumer purchasing power during 1933-'37

Table 7. Corn-hog and barley-hog ratios at farm prices in Michigan, 1934-37.*

(number of pounds of corn and of barley equal in value to 100 pounds of live hogs)

Corn-hog ratio

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ave.
1934	370	459	448	398	364	336	381	353	414	392	375	342	381
1935	470	510	605	582	582	610	610	756	784	739	862	1008	675
1936	990	1033	1055	1044	957	994	715	571	583	548	525	537	731
1937	554	538	532	445	453	489	518	627	608	780	871	814	602
1938	819	829	913	840	799								
1939													

Barley-hog ratio

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ave.
1934	293	355	346	331	312	298	355	341	365	350	317	307	331
1935	422	475	542	547	600	691	888	1224	1176	1018	893	882	780
1936	883	889	891	898	849	832	752	526	500	475	476	451	644
1937	456	423	442	421	444	567	698	944	904	867	708	648	627
1938	632	640	728	670	660								
1939													

*To supplement Tables 44 and 45, p. 69, Mich. Agr. Exp. Sta. Tech. Bul. 139.

During 1910-20, 100 lbs. of hogs were equal in value to 594 lbs. of corn and 552 lbs. of barley; during 1921-30, to 638 lbs. of corn and 658 lbs. of barley.

Table 8. Prices paid to producers for sheep in Michigan.*

(dollars per 100 pounds)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Wtd. Ave.
1910-14	4.30	4.28	4.68	4.96	4.72	4.48	4.36	4.34	4.12	3.96	3.92	3.86	4.23
1924-28	6.20	6.54	6.74	6.44	6.60	6.26	5.94	5.92	6.04	5.98	5.66	6.04	6.19
1929	6.50	6.80	7.30	7.10	6.70	6.50	6.00	6.10	5.80	5.50	5.50	5.60	6.17
1930	5.60	5.50	5.40	5.40	5.20	4.50	3.50	3.60	3.50	3.30	3.00	3.40	4.29
1931	3.30	3.70	3.80	3.90	3.20	2.60	2.70	2.40	2.30	2.30	2.10	2.10	2.83
1932	2.20	2.10	2.50	2.70	2.10	2.20	2.30	1.90	2.10	2.10	1.90	1.85	2.12
1933	1.85	1.85	1.95	2.00	2.10	2.20	2.50	2.25	2.20	2.10	2.15	2.05	2.04
1934	2.15	2.90	3.05	2.90	2.75	2.50	2.30	2.20	2.20	2.30	2.20	2.20	2.43
1935	2.80	3.40	2.70	3.60	3.26	3.20	2.95	3.10	3.20	3.30	3.30	3.50	3.29
1936	3.90	3.75	3.70	3.75	3.80	3.65	3.10	3.30	3.00	3.10	3.20	3.10	3.44
1937	4.10	4.05	4.80	4.70	4.25	4.25	4.30	4.50	4.10	4.10	3.60	3.50	4.05
1938	3.70	3.25	3.65	3.60	3.35	3.25							
1939													

*To supplement Table 46, p. 73, Mich. Agr. Exp. Sta. Tech. Bul. 139.

the livestock farmer in general had costs relatively higher than were the prices of farm products.

The three groups of livestock and their products for which indexes of prices have been prepared are (1) meat animals and wool, (2) poultry products, and (3) dairy products. Prices and indexes for horses and dairy cows are also included. The annual weighted average prices are calculated by weighting the monthly prices by the monthly sales.

Meat Animals and Wool

The six products included in this group are: cattle, calves, hogs, sheep, lambs, and wool.

Cattle and Calves—The farm price of cattle and calves which were sold for beef and veal, respectively, declined drastically from their high level of 1929, primarily because of deflation, decline in consumer pur-

Table 9. Index numbers of prices paid to producers for sheep in Michigan.*

(1910-'14 = 100)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Wtd. Ave.
1910-14	101	101	111	117	111	106	103	105	98	93	93	91	100
1924-28	146	155	159	161	156	148	140	140	143	142	134	143	146
1929	154	161	173	168	158	154	142	144	137	130	130	132	146
1930	132	130	128	128	123	106	83	85	83	78	71	80	101
1931	78	87	90	92	76	61	64	57	54	54	50	50	67
1932	52	50	59	64	50	52	54	45	50	50	45	44	50
1933	44	44	46	47	50	52	59	53	52	50	51	48	48
1934	51	69	72	69	65	59	54	52	52	54	52	52	57
1935	66	80	87	85	77	76	70	73	76	78	78	83	78
1936	92	89	87	89	90	86	73	78	71	73	76	73	81
1937	97	96	113	111	100	100	102	106	97	97	85	83	96
1938	87	77	86	85	79	77							
1939													

*To supplement Table 47, p. 73, Mich. Agr. Exp. Sta. Tech. Bul. 139.

chasing power, and because of the expansion in numbers and marketings during 1930-'33 (Tables 1-4 and Fig. 1). An unusual rapid rise in farm prices occurred during the latter part of 1934 on account of previous reduction in numbers, and because the effects of inflation on livestock had been delayed.

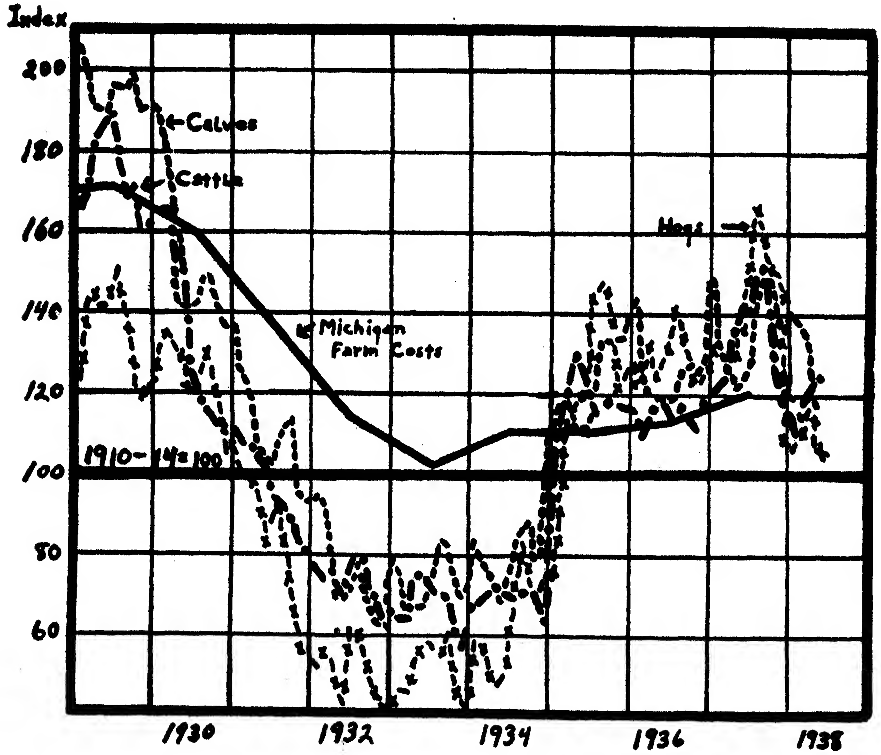

Fig. 1. Index numbers of farm prices of cattle, calves and hogs and farm costs in Michigan, 1929-'37. The farm prices of the meat animals declined more rapidly than did farm costs during 1924-'32, but also rose more rapidly during 1933-'37.

Hogs—Hog prices declined during the deflation of 1929-'32 to a low of $2.95 a hundredweight in December 1932, which was probably the lowest since 1900 (Tables 5 and 6 and Fig. 1). Inflation, reduction programs and the drouths carried hog prices to a very favorable relationship to farm costs during 1935-'37.

Since 1920, a hundred pounds of hogs at farm prices has averaged in value about the same as 640 pounds of corn or 660 pounds of barley. When hogs would buy more corn or barley, the feeding ratio has usually been favorable and hog production has been expanded. An unfavorable feed ratio has tended to contract hog production. The high feed prices following the drouths of 1934 and 1936 resulted in unfavorable corn-hog and barley-hog ratios and encouraged farmers

Table 10. Prices paid to producers for lambs in Michigan.*

(dollars per 100 pounds)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Wtd. Ave.
1910-14	6.36	6.32	6.64	6.68	6.64	6.52	6.32	6.30	6.04	5.82	5.66	5.88	6.15
1924-28	12.22	12.56	13.14	12.90	12.68	12.98	12.58	11.98	11.96	11.92	11.86	12.14	12.24
1929	13.90	14.60	14.50	14.30	13.30	13.10	13.20	12.10	11.90	11.50	11.20	11.60	12.75
1930	12.10	11.30	10.10	9.00	8.90	10.00	9.20	7.90	7.70	6.70	7.00	6.60	8.72
1931	7.10	7.50	7.70	8.10	7.90	7.40	6.80	6.50	6.20	5.70	5.20	4.90	6.45
1932	5.00	5.00	5.60	5.90	5.00	5.10	5.30	5.20	5.00	4.65	4.65	4.70	4.98
1933	4.85	4.95	4.85	4.65	5.20	5.80	6.00	6.10	5.80	5.60	5.50	5.60	5.30
1934	6.30	7.70	7.80	7.20	7.50	7.40	6.70	5.80	5.70	5.60	5.50	5.90	6.37
1935	7.60	7.90	7.90	7.40	7.50	7.60	7.30	7.50	8.20	8.20	9.10	9.20	8.19
1936	9.70	9.50	9.00	8.90	9.00	9.20	8.90	8.90	8.60	8.30	8.10	8.30	8.79
1937	9.50	9.40	10.90	10.90	9.90	9.80	9.30	9.80	9.80	9.50	8.90	8.30	9.49
1938	7.80	6.80	8.00	7.50	7.00	7.40							
1939													

*To supplement Table 48, p. 74, Mich. Agr. Exp. Sta. Tech. Bul. 139.

to reduce the number of gilts kept for breeding and to sell hogs at lighter weights (Table 7 and Fig. 2).

Sheep and Lambs—The deflation of 1929-'32 caused a precipitous decline in the farm prices of lambs and especially sheep (Tables 8-11 and Fig. 3). Sheep touched a low of $1.85 a hundredweight in 1932-'33.

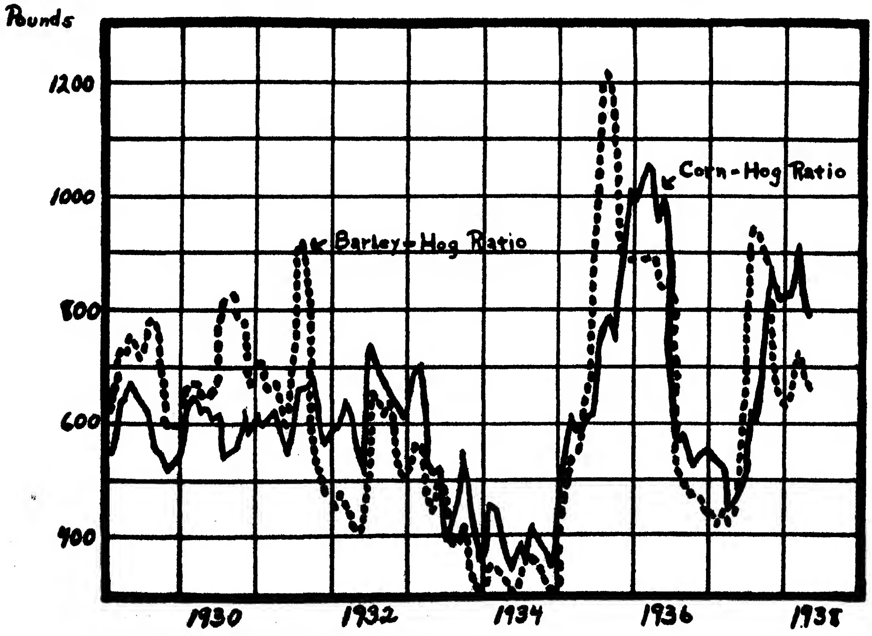

Fig. 2. Corn-hog and barley-hog ratios in Michigan, 1929-'37. (Number of pounds of grain equal in value to 100 pounds of live hogs, at farm prices.) Farmers keep more gilts when a hog will buy more corn or barley and reduces the number of hogs when feed is expensive relatively to hogs.

Table 11. Index numbers of prices paid to producers for lambs in Michigan.*

(dollars per 100 pounds)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Wtd. Ave.
1910-14	101	102	108	109	108	106	103	102	98	95	92	96	100
1924-28	199	204	214	210	206	211	204	195	195	194	193	197	200
1929	226	237	236	233	216	213	215	197	193	187	182	186	207
1930	197	184	164	146	145	163	150	128	125	109	114	107	142
1931	115	122	125	132	128	120	111	106	101	93	85	80	105
1932	81	81	91	96	81	83	86	85	81	76	76	76	81
1933	79	80	79	76	85	94	98	99	94	91	89	91	86
1934	102	125	127	117	122	120	109	94	93	91	89	96	104
1935	124	128	128	120	122	124	119	122	133	133	148	148	133
1936	158	154	146	145	146	150	145	145	140	135	131	135	143
1937	154	153	177	177	161	159	151	159	159	154	145	135	154
1938	127	111	130	122	114	120							
1939													

*To supplement Table 49, p. 74, Mich. Agr. Exp. Sta. Tech. Bul. 139.

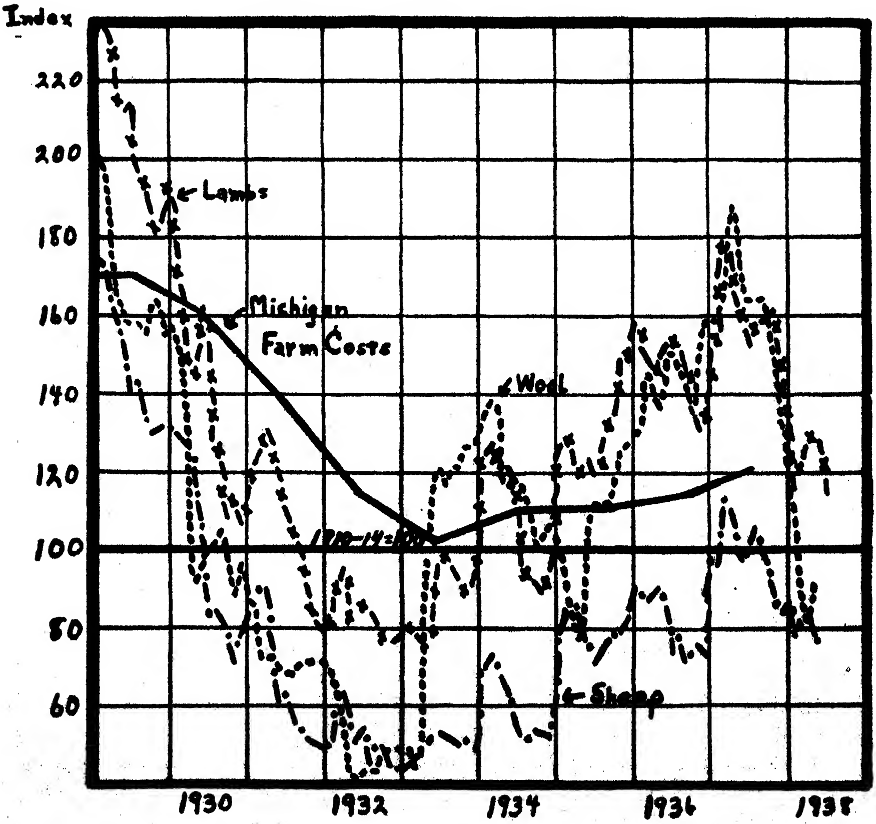

Fig. 3. Index numbers of farm prices of sheep, lambs and wool and farm costs in Michigan, 1929-'37. Farm costs have been relatively higher than prices of farm products during most of the last decade.

Table 12. Prices paid to producers for wool in Michigan.*

(cents per pound)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Wtd. Ave.
1910-14	22	22	21	20	20	21	21	21	21	21	21	20	20.7
1924-28	41	41	41	38	37	36	38	38	38	40	41	42	37.8
1929	43	42	40	34	34	33	33	33	32	34	34	32	33.2
1930	33	32	29	23	19	20	21	21	22	20	18	20	21.0
1931	18	18	15	15	15	14	14	14	15	15	15	15	14.5
1932	15	14	13	11	9	8	9	9	9	10	10	10	9.0
1933	10	10	9	10	19	24	25	24	25	25	26	26	21.2
1934	27	28	29	28	24	24	24	24	23	21	22	22	24.5
1935	21	20	17	16	17	22	23	23	23	24	26	26	20.7
1936	27	27	30	29	29	31	31	30	29	28	30	33	29.9
1937	33	33	34	39	36	34	34	34	34	32	30	27	35
1938	25	23	18	17	19	18							
1939													

*To supplement Table 51, p. 76, Mich. Agr. Exp. Sta. Tech. Bul. 139.

Lambs recovered rapidly with the improvement in demand during 1934-'37, fell again during the slump in business activities beginning in 1937. Sheep prices have remained considerably below their pre-depression level.

Wool—The price of wool has been affected during the last decade primarily by inflation and deflation and the changes in domestic and foreign demand (Tables 12 and 13, and Fig. 3).

Table 13. Index numbers of prices paid to producers for wool in Michigan.*

(1910-'14 = 100)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Wtd. Ave.
1910-14	106	106	101	97	97	101	101	101	101	101	101	97	100
1924-28	198	198	198	184	179	174	184	181	184	193	198	203	183
1929	208	203	193	164	164	159	159	159	155	164	164	155	160
1930	159	155	140	111	92	97	101	101	106	97	87	97	101
1931	87	87	72	72	72	68	68	68	72	72	72	72	70
1932	72	68	63	53	43	39	43	43	43	48	48	48	43
1933	48	48	43	48	92	116	121	116	121	121	126	126	102
1934	130	135	140	135	116	116	116	116	111	101	106	106	118
1935	101	97	82	77	82	106	111	111	111	116	126	126	100
1936	130	130	145	140	140	150	150	145	140	135	145	159	144
1937	159	159	164	188	174	164	164	164	164	155	145	130	169
1938	121	111	87	82	92	87							
1939													

*To supplement Table 51, p. 76, Mich. Agr. Exp. Sta. Tech. Bul. 139.

Horses

The farm prices of horses were rising because of a shortage of horses when deflation began in 1929 (Tables 14 and 15). Consequently, the prices did not decline so drastically as other farm animals during 1929-'33, and have since risen to the pre-depression level. The substitution of mechanical power for horses is tending to counteract the effect of a shortage of horses on prices.

Table 14. Prices paid to producers for horses in Michigan.*

(dollars per head)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ave.
1910-14	168	172	174	176	173	171	175	173	169	168	166	166	171
1924-28	98	102	107	110	109	109	107	104	105	105	102	101	105
1929	115	120	125	130	133	131	133	128	125	125	120	118	125
1930	118	116	121	126	126	123	112	109	107	105	107	107	115
1931	106	107	112	115	115	113	105	100	102	102	95	93	105
1932	98	105	100	110	105	104	102	104	99	101	101	98	102
1933	102	107	107	112	116	120	120	125	125	120	115	115	115
1934	119	128	128	133	137	138	133	129	127	120	115	113	127
1935	122	133	137	142	142	142	137	134	139	138	134	130	135
1936	129	135	145	155	160	155	160	149	146	143	139	132	146
1937	145	145	145	148	145	142	149	145	140	140	135	130	142
1938	125	120	132	139	133	141							
1939													

*To supplement Table 53, p. 78, Mich. Agr. Exp. Sta. Tech. Bul. 130.

Table 15. Index numbers of prices paid to producers for horses in Michigan.*

(1910-'14 = 100)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ave.
1910-14	98	100	102	103	101	100	102	101	99	98	97	97	100
1924-28	57	54	62	66	64	64	63	61	62	62	59	58	61
1929	67	70	73	76	78	77	78	75	73	73	70	69	73
1930	69	68	71	74	74	72	65	64	62	61	62	62	67
1931	62	62	65	67	67	66	61	58	60	60	56	54	61
1932	57	61	58	64	61	61	60	61	58	59	59	57	60
1933	60	62	62	65	68	70	70	73	73	70	67	67	70
1934	70	75	75	78	80	81	78	75	74	70	67	66	75
1935	71	78	80	83	83	83	80	78	81	81	73	76	77
1936	75	79	85	91	94	91	94	87	85	84	81	77	85
1937	85	85	85	86	85	80	87	85	82	82	79	76	83
1938	73	70	77	81	78	82							
1939													

*To supplement Table 54, p. 78, Mich. Agr. Exp. Sta. Tech. Bul. 130.

Poultry Products

The farm prices of chickens and eggs followed the movement of other farm prices during 1929-'37 but at a relatively higher level (Tables 16-19 and Fig. 4). The seasonal variation of egg prices is greater than for any of the other animal products.

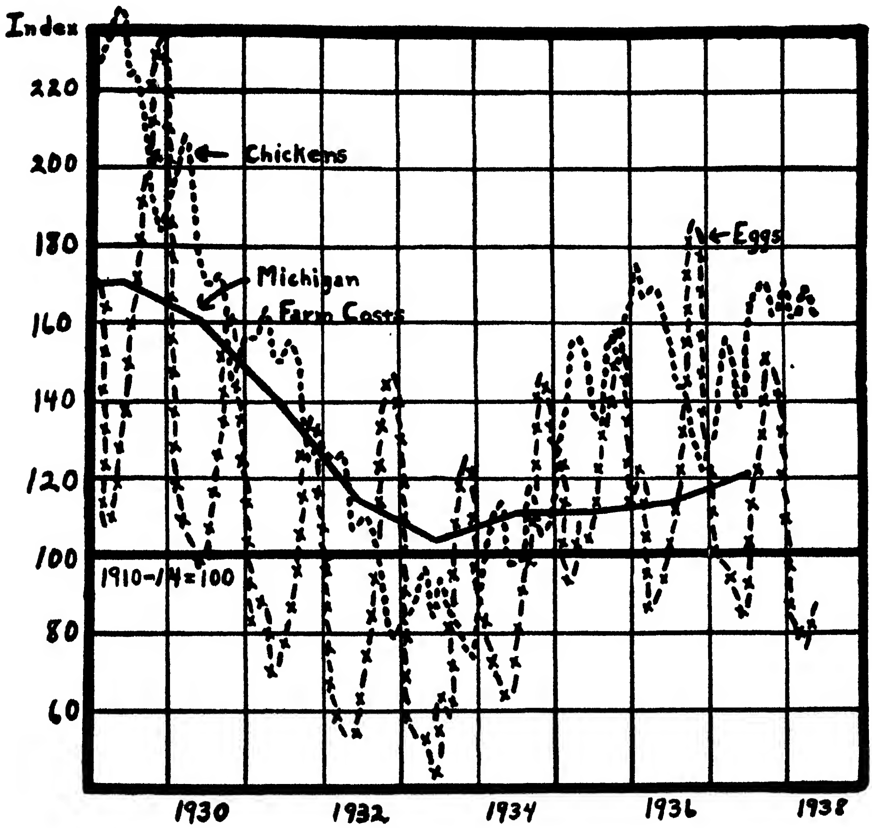

Fig. 4. Index numbers of farm prices of chickens and eggs, and farm costs in Michigan, 1929-'37.

Table 16. Prices paid to producers for chickens in Michigan.*

(cents per pound)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Wtd. Ave.
1910-14	10.6	10.9	11.5	12.0	11.8	11.7	12.0	11.8	11.7	11.2	10.3	10.0	10.9
1924-28	20.0	20.9	21.5	23.0	23.0	22.3	21.9	21.4	21.4	20.7	20.4	20.0	20.9
1929	24.3	24.5	25.0	25.5	26.5	25.7	24.4	24.5	23.8	22.3	21.0	20.1	22.8
1930	20.6	21.2	22.0	22.8	21.6	19.1	18.6	18.5	18.7	17.8	15.8	16.3	18.4
1931	17.0	17.0	17.0	17.9	17.1	16.4	16.3	16.9	16.5	14.5	13.5	13.8	15.4
1932	14.0	13.5	13.6	13.8	12.8	11.5	12.0	12.0	11.2	10.5	9.1	8.6	11.0
1933	9.2	9.1	9.5	10.0	10.6	9.3	10.3	9.4	9.3	8.9	8.2	8.1	8.9
1934	9.3	10.6	11.5	12.2	12.3	10.7	10.7	10.8	12.9	12.0	11.4	11.9	11.4
1935	13.0	14.0	15.0	17.0	17.0	16.2	15.0	14.8	16.6	17.0	16.3	17.6	16.1
1936	17.9	19.1	18.1	18.4	18.4	17.5	16.8	15.6	15.6	14.2	14.0	13.2	15.6
1937	14.1	14.2	16.0	17.0	16.0	15.0	16.0	18.0	18.5	18.5	17.6	17.8	16.9
1938	18.9	17.5	17.6	18.4	17.6	17.2							
1939													

*To supplement Table 56, p. 81, Mich. Agr. Exp. Sta. Tech. Bul. 139.

Table 17. Index numbers of prices paid to producers for chickens in Michigan.*

(1910-'14 = 100)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Wtd. Ave.
1910-14	97	100	106	110	108	107	110	108	107	103	94	92	100
1924-28	183	192	197	211	211	205	201	196	196	190	187	183	192
1929	223	225	229	234	243	236	224	225	218	205	193	184	209
1930	189	194	202	209	198	175	171	170	172	163	145	150	169
1931	156	156	156	164	157	150	150	155	151	133	124	127	141
1932	128	124	125	127	117	106	110	110	103	96	83	79	101
1933	84	83	87	92	97	85	94	86	85	82	75	74	82
1934	85	97	106	112	114	98	98	99	118	110	105	109	105
1935	119	128	138	156	156	149	138	136	152	156	150	161	148
1936	164	175	166	169	169	161	154	143	143	130	128	121	143
1937	129	130	147	156	147	138	147	165	170	170	161	163	155
1938	173	161	161	169	161	158							
1939													

*To supplement Table 57, p. 81, Mich. Agr. Exp. Sta. Tech. Bul. 139.

Table 18. Prices paid to producers for eggs in Michigan.*

(cents per dozen)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Wtd. Ave.
1910-14	28	26	21	17	17	18	18	19	22	24	27	28	20.4
1924-28	42	35	25	24	24	25	26	29	32	35	47	49	29.1
1929	35	35	22	24	25	27	29	33	36	41	46	48	31.2
1930	40	34	23	22	21	20	21	23	26	29	33	28	24.4
1931	23	17	18	18	14	15	16	17	20	23	28	24	17.8
1932	18	14	12	11	11	11	13	15	17	24	29	30	14.5
1933	22	12	11	11	11	9	13	12	15	22	26	22	13.3
1934	18	17	15	14	13	13	13	17	21	23	30	27	16.5
1935	25	27	19	20	22	21	22	23	28	29	32	31	23.2
1936	22.1	25.1	19.9	17.2	18.4	19.3	20.7	23.3	23.9	28.4	38.2	32.4	21.6
1937	23.4	20.1	20.2	20.7	17.9	17.4	20.0	22.0	24.4	27.7	31.2	26.9	21.1
1938	23.2	17.0	16.9	15.6	18.0	18.7							
1939													

*To supplement Table 58, p. 82, Mich. Agr. Exp. Sta. Tech. Bul. 139.

Table 19. Index numbers of prices paid to producers for eggs in Michigan.*

(1910-'14 = 100)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Wtd. Ave.
1910-14	137	127	103	83	83	88	88	93	108	118	132	137	100
1924-28	206	172	123	118	118	123	127	142	157	172	230	240	143
1929	172	172	108	118	123	132	142	162	176	201	225	235	153
1930	196	167	113	108	103	98	103	113	127	142	162	137	120
1931	113	83	88	88	69	74	78	83	98	113	137	118	87
1932	88	69	59	54	54	54	64	74	83	118	142	147	71
1933	108	59	54	54	54	44	64	59	74	108	127	108	65
1934	88	83	74	69	64	64	64	83	103	113	147	132	81
1935	123	132	93	98	108	103	108	113	137	142	157	152	114
1936	108	123	98	84	90	95	102	114	117	139	187	159	106
1937	115	99	99	101	88	85	98	108	120	136	153	132	103
1938	114	83	83	76	88	92							
1939													

*To supplement Table 59, p. 82, Mich. Agr. Exp. Sta. Tech. Bul. 139.

Dairy Products

The prices of dairy products declined with deflation and the reduced consumer demands during 1929-'33, but less drastically than most other farm products (Tables 20-23 and Fig. 5). The trend of increased consumption per capita of dairy products was broken by the depression and the revival of business activity strengthened the prices of butter and milk.

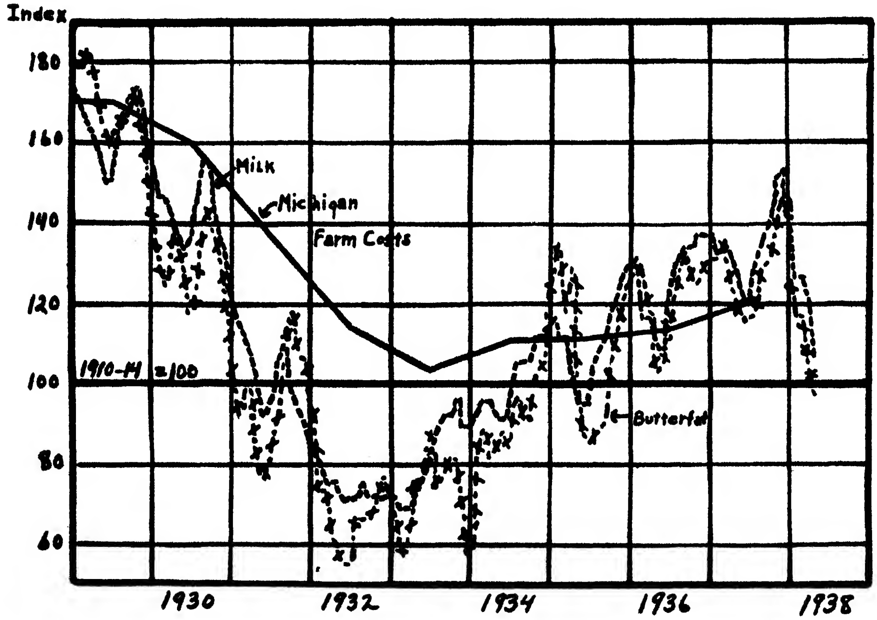

Fig. 5. Index numbers of farm prices of milk at wholesale, butterfat and farm costs in Michigan, 1929-'37.

Table 20. Prices paid to producers for milk at wholesale in Michigan.*

(dollars per 100 pounds)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Wtd. Ave.
1910-14	1.73	1.71	1.57	1.34	1.16	1.13	1.26	1.40	1.52	1.70	1.78	1.83	1.47
1924-28	2.40	2.36	2.32	2.26	2.16	2.09	2.18	2.28	2.32	2.38	2.42	2.43	2.29
1910	1.55	1.55	1.40	1.35	1.10	1.10	1.20	1.35	1.50	1.70	1.75	1.75	1.41
1911	1.75	1.70	1.60	1.25	1.05	1.05	1.20	1.35	1.50	1.60	1.75	1.75	1.43
1912	1.65	1.65	1.50	1.30	1.15	1.10	1.25	1.40	1.50	1.70	1.80	1.85	1.45
1913	1.85	1.80	1.60	1.35	1.25	1.20	1.30	1.45	1.55	1.75	1.80	1.90	1.53
1914	1.85	1.85	1.75	1.45	1.25	1.20	1.35	1.45	1.55	1.75	1.80	1.90	1.56
1915	1.85	1.85	1.75	1.40	1.25	1.20	1.35	1.45	1.55	1.70	1.75	1.85	1.55
1916	1.75	1.70	1.65	1.40	1.30	1.25	1.45	1.65	1.70	2.00	2.05	2.10	1.63
1917	2.15	2.25	2.15	1.90	1.65	1.65	2.20	2.45	2.55	2.70	2.80	3.25	2.26
1918	3.30	3.20	3.15	2.75	2.35	2.10	2.45	2.90	3.20	3.40	3.55	3.85	2.94
1919	3.75	3.60	3.30	3.15	3.00	2.90	3.25	3.70	3.80	3.90	3.90	3.90	3.47
1920	3.80	3.75	3.55	3.40	3.10	3.05	3.35	3.45	3.70	3.50	3.45	2.70	3.39
1921	2.55	2.30	2.30	2.30	2.10	1.95	2.00	2.25	2.25	2.25	2.15	2.20	2.20
1922	2.15	2.15	1.95	1.90	1.90	1.85	1.95	2.15	2.20	2.20	2.35	2.55	2.09
1923	2.60	2.50	2.45	2.40	2.30	2.25	2.35	2.60	2.65	2.70	2.55	2.55	2.48
1924	2.45	2.40	2.30	2.10	2.00	1.95	2.05	2.10	2.15	2.20	2.15	2.20	2.16
1925	2.25	2.20	2.20	2.20	2.15	2.10	2.20	2.30	2.30	2.35	2.45	2.45	2.25
1926	2.40	2.35	2.30	2.25	2.15	2.10	2.15	2.30	2.30	2.40	2.45	2.45	2.28
1927	2.45	2.45	2.45	2.40	2.25	2.15	2.20	2.30	2.40	2.45	2.50	2.50	2.36
1928	2.45	2.40	2.35	2.35	2.25	2.15	2.30	2.40	2.45	2.50	2.55	2.55	2.38
1929	2.55	2.50	2.45	2.40	2.30	2.20	2.25	2.40	2.45	2.55	2.55	2.40	2.40
1930	2.25	2.15	2.15	2.10	2.00	1.95	2.00	2.10	2.30	2.20	2.05	1.95	2.09
1931	1.80	1.70	1.65	1.60	1.50	1.35	1.40	1.55	1.60	1.50	1.40	1.35	1.52
1932	1.25	1.20	1.15	1.10	1.10	1.05	1.05	1.05	1.10	1.05	1.05	1.05	1.10
1933	1.05	1.05	1.00	1.00	1.05	1.10	1.20	1.30	1.35	1.35	1.40	1.30	1.19
1934	1.30	1.35	1.40	1.40	1.35	1.35	1.45	1.55	1.55	1.55	1.65	1.65	1.46
1935	1.65	1.70	1.65	1.65	1.50	1.40	1.50	1.55	1.60	1.70	1.75	1.85	1.61
1936	1.90	1.90	1.70	1.70	1.65	1.60	1.80	1.90	1.95	1.95	2.00	2.00	1.82
1937	2.00	1.95	1.95	1.95	1.90	1.80	1.80	1.90	2.00	2.05	2.20	2.25	2.13
1938	2.10	1.85	1.85	1.80	1.60	1.55							
1939													

*To replace Table 60, p. 84, Mich. Agr. Exp. Sta. Tech. Bul. 139.

Table 21. Index numbers for prices paid to producers for milk at wholesale in Michigan.*

(1910-'14 = 100)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Wtd. Ave.
1910-14	118	116	107	91	79	77	86	95	103	116	121	124	100
1924-28	163	161	158	154	147	142	148	155	158	162	165	165	156
1910	105	105	95	92	75	75	82	92	102	116	119	119	95
1911	119	116	109	85	71	71	82	92	102	109	119	119	96
1912	112	112	102	88	78	75	85	95	102	116	122	126	97
1913	126	122	109	92	85	82	88	99	105	119	122	129	104
1914	126	126	119	99	85	82	92	99	105	119	122	129	106
1915	126	126	119	95	85	82	92	99	105	116	119	126	105
1916	119	116	112	95	88	85	99	112	116	136	139	143	111
1917	146	153	146	129	112	112	150	167	173	184	190	221	154
1918	224	218	214	187	160	143	167	197	218	231	241	262	200
1919	255	245	224	214	204	197	221	252	259	265	265	265	236
1920	259	255	241	231	211	207	228	235	252	238	235	184	231
1921	173	156	156	156	143	133	136	153	153	153	146	150	150
1922	146	146	133	129	129	126	133	146	150	150	160	173	142
1923	177	170	167	163	156	153	160	177	180	184	173	173	169
1924	167	163	156	143	136	133	139	143	146	150	146	150	147
1925	153	150	150	150	146	143	150	150	156	160	167	167	153
1926	163	160	156	153	146	143	146	156	156	163	167	167	155
1927	167	167	167	163	153	146	150	156	163	167	170	170	161
1928	167	163	160	160	153	146	156	163	167	170	173	173	162
1929	173	170	167	163	156	150	153	163	167	173	173	163	163
1930	153	146	146	143	136	133	136	143	156	150	139	133	142
1931	122	116	112	109	102	92	95	105	109	102	95	92	103
1932	85	82	78	75	75	71	71	71	75	71	71	71	75
1933	71	71	68	68	71	75	82	88	92	92	95	88	81
1934	88	92	95	95	92	92	99	105	105	105	112	112	99
1935	112	116	112	112	102	95	95	105	109	116	119	126	110
1936	129	129	116	116	112	109	122	129	133	133	136	136	124
1937	136	133	133	133	129	122	122	129	136	139	150	153	145
1938	143	126	126	122	109	105							
1939													

*To replace Table 61, p. 84, Mich. Agr. Exp. Sta. Tech. Bul. 139.

Table 22. Prices paid to producers for butterfat in Michigan.*

(cents per pound)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Wtd. Ave.
1910-14	31	28	28	28	25	24	24	25	27	28	31	33	27.2
1924-28	48	47	47	45	42	42	42	41	44	45	46	49	44.2
1910	32	27	29	30	26	26	25	26	27	26	27	27	27.2
1911	24	22	22	20	20	20	21	22	22	26	30	32	22.8
1912	32	29	28	32	28	24	24	24	27	29	34	37	28.3
1913	34	34	35	33	28	26	25	26	29	28	32	36	29.9
1914	32	27	26	25	25	26	26	28	29	30	33	34	27.9
1915	33	30	28	30	27	27	25	24	25	26	30	34	27.9
1916	32	31	35	35	31	28	27	29	32	34	39	40	32.1
1917	39	40	41	43	42	38	38	40	42	43	45	49	41.2
1918	50	47	41	44	44	42	43	45	55	56	60	66	48.1
1919	62	48	59	65	60	53	53	54	57	64	67	67	58.4
1920	65	62	65	67	60	58	57	55	57	58	58	48	59.3
1921	49	43	45	44	28	26	33	42	40	42	45	44	38.8
1922	34	34	34	35	34	35	35	32	35	39	45	53	36.4
1923	50	47	47	47	41	37	38	40	45	45	50	52	44.5
1924	53	51	47	42	38	39	41	37	40	38	38	43	41.9
1925	41	39	43	42	41	41	42	42	45	49	49	49	43.2
1926	46	45	44	41	40	41	40	40	42	44	46	52	42.8
1927	49	50	52	51	45	43	42	41	44	47	47	50	46.3
1928	50	48	48	47	46	45	44	46	48	48	48	50	47.0
1929	49	49	50	47	46	44	43	44	45	47	45	43	45.8
1930	37	36	34	38	37	32	32	36	39	38	37	32	35.5
1931	28	25	27	27	22	21	22	25	28	32	29	29	25.6
1932	24	20	20	18	16	15	15	18	18	18	19	21	18.1
1933	19	16	16	17	20	20	24	20	21	22	22	19	19.8
1934	16	22	24	22	23	24	23	26	25	25	28	29	23.7
1935	31	37	32	35	28	24	23	24	25	27	30	33	28.5
1936	34	36	33	32	28	29	33	36	36	35	34	35	33.0
1937	36	36	37	35	33	32	32	33	35	36	38	40	34.8
1938	35	32	32	28	27	25							
1939													

*To replace Table 62, p. 85, Mich. Agr. Exp. Sta. Tech. Bul. 139. The series of butterfat prices for 1910-19 was prepared by Mr. V. Church, Agric. Statistician of Michigan.

Table 23. Index numbers of prices paid to producers for butterfat in Michigan.*

(1910-'14 = 100)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Wtd. Ave.
1910-14	113	102	103	103	94	90	89	93	98	102	115	122	100
1924-28	176	171	172	164	155	158	154	152	161	166	168	179	163
1910	118	99	106	110	96	96	92	96	99	96	99	99	100
1911	88	81	81	74	74	74	78	81	81	96	110	117	84
1912	118	106	103	118	103	88	88	88	99	106	125	136	104
1913	125	125	129	121	103	96	92	96	106	103	118	132	110
1914	118	99	96	92	92	96	96	103	106	110	122	125	103
1915	121	110	103	110	99	99	92	88	92	96	110	125	103
1916	118	114	129	129	114	103	99	106	118	125	144	147	118
1917	144	147	151	158	155	140	140	147	155	158	166	180	152
1918	184	173	151	162	162	155	158	166	202	206	221	243	177
1919	228	177	217	239	221	195	195	199	210	236	247	247	215
1920	239	228	239	247	221	213	209	202	209	213	213	177	218
1921	180	158	166	162	103	96	121	155	147	155	166	162	143
1922	125	125	125	129	125	129	129	118	129	144	166	195	134
1923	184	173	173	173	151	136	140	147	166	166	184	191	164
1924	195	188	173	155	140	144	151	136	147	140	140	158	154
1925	151	144	158	155	151	151	155	155	166	180	180	180	159
1926	169	166	162	151	147	151	147	147	155	162	169	191	158
1927	180	184	191	188	166	158	155	151	162	173	173	184	170
1928	184	177	177	173	169	166	162	169	177	177	177	184	173
1929	180	180	184	173	169	162	158	162	166	173	166	158	169
1930	136	132	125	140	136	118	118	132	144	140	136	118	131
1931	103	92	99	99	81	77	81	92	103	118	106	106	94
1932	88	74	74	66	59	55	55	66	66	66	70	77	67
1933	70	59	59	63	74	74	88	74	77	81	81	70	73
1934	59	81	88	81	85	88	85	96	92	92	103	106	87
1935	114	136	118	129	103	88	85	88	92	99	110	121	105
1936	125	132	121	118	103	106	121	132	132	129	125	129	121
1937	132	132	136	129	121	118	118	121	129	132	140	147	128
1938	129	118	118	103	99	92							
1939													

*To replace Table 63, p. 85, Mich. Agr. Exp. Sta. Tech. Bul. 139.

Milk Cows

Milk cows reached a high price level in1929 because of the expanding demand and high prices of dairy products and the high price of beef. The prices declined from an average of $106 a head in 1929 to $34 in 1934 (Tables 24 and 25). Prices of dairy cows are affected primarily by the prices of dairy products, and lag behind the prices of the latter during both deflation and inflation.

Purchasing Power of Livestock

The length of the purchasing power cycle of the classes of livestock depends primarily on the time necessary to expand and contract production. The cycle for hogs is from 3 to 5 years, sheep from 7 to 10 years, beef cattle and dairy cows from 14 to 16 years, and the cycle in horses is about 24 years in length. The purchasing power of livestock has been increasing during recent years (Table 26).

Table 24. Prices paid to producers for milk cows in Michigan.*

(dollars per head)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ave.
1910-14	48	48	48	49	49	49	50	49	50	49	50	50	49
1924-28	70	69	72	74	74	75	75	75	76	77	77	78	75
1929	106	106	106	106	106	106	108	105	105	106	106	104	106
1930	100	95	88	87	84	82	76	70	70	69	68	65	80
1931	64	58	57	57	55	52	51	50	50	49	51	50	54
1932	46	44	42	42	40	38	38	38	36	36	34	34	39
1933	33	32	31	33	35	36	39	37	36	35	33	33	34
1934	31	32	33	33	33	32	32	27	30	28	28	30	31
1935	33	41	46	49	50	52	49	48	52	52	55	56	59
1936	60	57	56	59	62	57	59	58	58	57	60	56	58
1937	62	63	62	60	63	65	65	64	65	65	63	64	63
1938	62	62	62	63	62	65							
1939													

*To supplement Table 64, p. 88, Mich. Agr. Exp. Sta. Tech. Bul. 139.

Table 25. Index numbers of prices paid to producers for milk cows in Michigan.*

(1910-'14 = 100)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ave.
1910-14	98	98	98	100	100	100	102	100	102	100	102	102	100
1924-28	143	141	147	151	151	153	153	153	155	157	157	159	153
1929	216	216	216	216	216	216	220	214	214	216	216	212	216
1930	204	194	180	178	171	167	155	143	143	141	139	133	163
1931	131	118	116	116	112	112	104	102	102	100	104	100	110
1932	93	89	85	85	81	77	77	77	73	73	69	69	79
1933	67	65	63	67	77	73	80	76	73	71	67	67	69
1934	63	65	67	67	67	65	65	55	61	57	57	61	63
1935	67	84	94	100	102	106	100	98	106	106	112	114	99
1936	122	116	114	120	126	116	120	118	118	116	122	114	119
1937	126	128	126	122	128	132	132	130	132	132	128	130	129
1938	126	126	126	128	126	132							
1939													

*To supplement Table 65, p. 88, Mich. Agr. Exp. Sta. Tech. Bul. 139.

Table 26. Farm value and purchasing power of beef cattle, hogs, sheep, horses and milk cows, 1929-'37.*

Year	Wholesale Price Index**	Beef Cattle			Hogs			Sheep			Horses			Milk Cows		
		Value per Head Jan. 1	Index Number	Purchasing Power	Value per Head Jan. 1	Index Number	Purchasing Power	Value per Head Jan. 1	Index Number	Purchasing Power	Value per Head Jan. 1	Index Number	Purchasing Power	Value per Head Jan. 1	Index Number	Purchasing Power
1910-14	100	$21.40	100	100	$10.52	100	100	$ 4.36	100	100	$132.40	100	100	$45.64	100	100
1924-28	145	29.67	139	96	13.48	128	88	10.55	242	167	88.20	67	46	67.20	147	102
1929	140	43.17	202	138	12.20	116	83	10.90	250	178	110.00	83	59	99.00	217	155
1930	135	42.68	199	147	12.30	117	87	10.10	232	172	111.00	84	62	99.00	217	161
1931	115	26.42	123	107	10.50	100	87	5.20	119	103	98.00	74	64	62.00	136	118
1932	99	19.31	90	91	6.90	66	67	3.90	89	90	97.00	73	74	45.00	99	100
1933	90	15.62	73	81	4.80	46	51	3.10	71	79	91.00	69	77	33.00	72	80
1934	104	12.66	59	57	4.10	39	37	4.00	92	88	105.00	79	76	30.00	66	63
1935	114	13.46	63	55	6.60	63	55	4.60	106	93	114.00	86	75	35.00	77	68
1936	118	24.93	116	98	14.50	138	117	7.00	161	136	136.00	103	87	57.00	125	106
1937	124	26.35	123	99	12.30	117	94	6.60	151	122	143.00	108	87	60.00	131	106
1938	118	26.61	124	105	12.50	119	101	6.70	154	130	128.00	97	82	63.00	138	117
1939																

*The purchasing power index is calculated by dividing the index of value per head by the index of wholesale prices of all commodities. The indexes supplement Table 38, p. 62; Table 43, p. 68; Table 50, p. 75; Table 55, p. 79 and Table 66, p. 89.
**Average of December and January.

Weighted Annual Prices and Index Numbers

The annual prices are weighted averages instead of arithmetic averages as in earlier studies. The weighted average annual prices and index numbers of same for 1910-'28 for livestock and livestock products which are not included in previous tables are included in Table 27. The weighted average prices are usually lower than the arithmetic average since the largest proportion of each product is generally marketed during the months of low prices. The arithmetic and weighted averages for beef cattle and calves are practically the same.

Table 27. Weighted annual prices and index numbers of weighed annual price paid to producers for Michigan farm products, 1910-'28.

Year	Farm Prices*					Index Numbers of Farm Prices**				
	Sheep	Lambs	Wool	Chickens	Eggs	Sheep	Lambs	Wool	Chickens	Eggs
	Dollars Per 100 Pounds		Cents Per Pound		Cents Per Dozen					
1910-14	4.23	6.15	20.5	10.9	20.4	100	100	100	100	100
1910	4.82	6.58	22.7	11.1	21.8	114	107	111	102	107
1911	3.66	5.12	18.0	10.1	17.4	87	83	88	93	85
1912	3.78	5.78	21.3	10.7	21.5	89	94	104	98	105
1913	4.35	6.63	18.5	11.4	20.4	103	108	90	105	100
1914	4.54	6.63	21.8	11.3	20.9	107	108	106	104	102
1915	4.70	7.17	28.7	10.9	13.5	111	117	140	100	91
1916	5.85	8.71	34.0	13.3	22.6	138	142	166	122	111
1917	8.33	12.71	58.0	16.8	32.5	197	207	283	154	159
1918	9.43	14.08	65.0	21.0	37.4	223	229	317	193	183
1919	8.67	13.41	56.7	22.7	42.1	205	218	277	208	206
1920	7.32	12.48	44.5	23.5	45.3	173	203	217	216	222
1921	4.07	7.80	18.7	19.2	29.2	96	127	91	176	143
1922	5.67	10.95	33.0	18.1	26.4	134	178	161	166	129
1923	6.08	11.69	42.8	18.2	27.6	144	190	209	167	135
1924	5.88	11.41	37.7	19.0	27.2	139	186	184	174	133
1925	6.59	13.08	39.0	20.7	31.7	156	213	190	190	155
1926	6.34	12.33	34.8	21.6	30.5	150	200	170	198	150
1927	5.89	12.02	33.7	21.0	26.4	139	195	164	193	129
1928	6.23	12.56	43.7	22.3	29.5	147	204	213	205	145

*Monthly prices are weighted by monthly marketings as reported in Mich. Agr. Exp. Sta. Tech. Bul. 139, Table 68, p. 93.
**Calculated by dividing weighted annual prices by 1910-14 average.

BULLETIN REVIEWS

Special Bulletin 290—Tomato Varieties.—Morrison, G.—Detailed descriptions are given, together with historical data and notes on suitability for different purposes and conditions of all of the more commonly grown tomato varieties. Less detailed descriptions are given of most of the varieties known to the American trade within the past three-quarters of a century. (68 pp., 1 table, 16 figs.)

Special Bulletin 291—A Decade of Michigan Cooperative Elevators.—Hedrick, W. O.—Cooperative elevator associations are the most numerous marketing cooperatives among Michigan farmers, some 98 furnishing the data for this study. From 1925 to 1935, associations of this character have increased in property values, in operating capital, in community service intensity and in the use of the patronage dividends. They have declined in numbers by nearly a fourth, declined in average annual business volume per year and declined in average membership per association. Important adjustments have been made as between supplies merchandising and produce shipments during this period, the former furnishing the major business for two-thirds of the elevators; the new organizational provision regarding preferred stockholders has been found useful in solving the problem member difficulty, and the Elevator Exchange holds its own as the chief jobbing outlet for these cooperative elevator associations.

The membership situation in these cooperatives is by far the most significant problem with which they are now confronted. The length of time which has elapsed since the period of organizational enthusiasm for these associations has dulled the interest of some as to acquiring new members. Business success has proved more attractive to these than has their success in cooperation, and with the passing away of the original members these organizations promise to become "just another elevator". On the other hand, a third of the associations are taking vigorous measures to renew their memberships and some of these have become very large in members and in financial success.

The federal government has done much for these cooperatives through exempting them from federal taxes. The provisions of credit resources both in respect to permanent improvements and in respect to working capital for these cooperatives by this same government furnishes further encouragement. (95 pp., 47 tables.)

Special Bulletin 292—Alfalfa Management, with Special Reference to Fall Treatment.—Rather, H. C. and Harrison, C. M.—Experiments with time of cutting alfalfa in early fall were conducted at East Lansing and at several over-state points in Michigan, over a three-year period. These tests showed that the complete removal of top growth of alfalfa by cutting or close grazing during the critical fall period lead to a depletion of root reserves without opportunity for replenishment. This depletion resulted in a subsequent increase in winter injury

and reduction of vigor and yield the following season. Based on these trials, the following suggestions are made for the fall management of alfalfa:

Avoid cutting or close grazing of alfalfa during the critical fall period for any given locality, August 15 to September 15 in northern Michigan and ranging to September 15 to October 15 in southern Michigan.

Permit sufficient top growth in the fall to enable the plants to store ample quantities of starch in the roots as reserve food to carry them through the winter and to initiate vigorous growth in the spring. Most of the storage in Michigan is accumulated during September.

If a fall cutting of hay or fall pasturage is badly needed, least injury will result if alfalfa, with roots well stored with food, is cut or pastured late enough in the fall so cold weather will prevent subsequent growth and the resultant depletion of root reserves.

Alfalfa which is to be plowed up may be cut or heavily grazed throughout September with the result that plowing the following spring will be less difficult. (18 pp., 7 figs., 6 tables.)

Special Bulletin 293—Methods of Preparing the Corn Crop for Yearling Steers.—Branaman, G. A., Brown, G. A., and Hudson, R. S.—Cutting and feeding shock corn to yearling steers was found to result in somewhat higher costs per hundredweight of gain than putting the well-eared corn into the silo and feeding silage. Grinding the shock corn resulted in slightly increased feeding efficiency, but was hardly warranted by the extra cost. (16 pp., 5 tables, 6 figs.)

Technical Bulletin 158—Influence of Heated and Unheated Testers on the Babcock Test.—Fahl, J. R., Lucas, P. S. and Baten, W. D.—A study was made of the influence of the heat of the Babcock tester on the accuracy of the resulting test. Tests run at low temperatures are lower than those run at room temperatures while tests run at high temperatures were slightly higher than those run at room temperatures. To check the accuracy of the Babcock test the same samples were run on the Mojonnier (Roese-Gottlieb) test. The Babcock test averages were 0.07 of 1 per cent higher than the average Mojonnier test. Heating the test left less residual fat in the bulb of the bottle, which probably accounts for the lower reading of cold tests. Statistical studies of the results showed the differences to be significant.

There is also reported a study of the accuracy of composite milk tests versus daily tests of milk. The daily test averages were almost 0.1 of 1 per cent higher than the composite test averages. The difference was undoubtedly due to measuring the milk for the composite test at too high temperatures. In order to be accurate it is recommended that the samples for the composite test be measured at a temperature not higher than 70° F.; if measured at 110-120° F. 0.1 of 1 per cent should be added to the reading of the composite sample measured at such temperature. (36 pp., 24 tables.)

JOURNAL ARTICLE ABSTRACTS

Pedologic Evidence of Changes of Climate in Michigan.—Veatch, J. O.—Papers of the Mich. Acad. Sci. XXIII: 385-390, 1937, published 1938. (Journal Article 264 (n. s.) from the Michigan Agricultural Experiment Station.) The mature soils of Michigan are regarded as an expression of the whole time which has elapsed since the retreat of the ice sheet, and not wholly a function of the existing climate and other present environment. The prairie soils of the southwestern part of the state, the podsols, characterized by conspicuous ortstein B horizons, on dry sites, and certain dry soils on the sites of former lake beds and marshes are regarded as evidence of changes of climate, since the soil profiles exhibit peculiarities not in accord with the present environment.

Carbon Dioxide Production in Manitol-Treated Soils as a Measure of Crop Response to Soil Treatments.—Andrews, W. B.—Jour. Am. Soc. Agron. 29 (4): 253-268. 1937. (Journal Article No. 274 (n. s.) from the Michigan Agricultural Experiment Station.)—A new procedure was developed to study the relation between crop response and response of micro-organisms to soil treatments and soil fertility levels. Manitol is added to the soil and the CO_2 produced is measured at the end of a 24-hour period. The short period involved and the taking of only one measurement are noteworthy. The method was applied to a large number of soil types which had been under experimental treatment at the Michigan, Mississippi, South Carolina, Florida, Missouri, and Louisiana stations. Samples were chosen from long continued fertilizer and rotation plats, from soils which showed response in crop growth to Cu, Mn, Mg, Zn, and As, and from soils which had been under rather unusual treatment in the greenhouse or field. Some subsoil samples were included. In some cases CO_2 production correlated closely with increases in plant growth, especially in soils receiving standard fertilizers and growing more commonly used crops. Results by the method agreed more closely with crop responses than did CO_2 production for a 24-day period using cellulose as a source of energy. In general CO_2 production did not correlate with crop response resulting from addition of Cu, Mn, Zn, As, etc.

A Study of Brucella Infection and Immunity in Humans—Huddleson, I. F., Gould, S. E., Munger, Myrtle, and Polson, Doris.—Am. Jour. Tropical Medicine. 17(6): 863-880. 1937. (Journal Article No. 307 (n. s.) from the Michigan Agricultural Experiment Station.)—A total of 5,801 males and 2,323 females have been studied to determine the extent of Brucella infection and immunity, by the aid of the Brucellergin skin test, the opsonic test, the agglutination test, blood, stool and urine culture. Of the total number examined, 10.3 per cent gave a positive skin test; 7.1 per cent were classified as infected; 2.7 per cent as immune, and 0.52 per cent as questionably immune.

No significant differences were noted between the incidence of infection and immunity in male and female groups.

The size of the skin reactions in approximately 50 per cent of those individuals who were positive fell between 25 and 75 mm.

Of the 222 classified as immune, 47.3 per cent showed insignificant serum agglutination titers. Of the 436 classified as infected, 90.5 per cent showed insignificant agglutination titers.

In a retest of 99 negative individuals after an interval of five months, 9 were found to have developed an allergy to Brucella. Of those, 5 were classified as infected and 4 as immune. In a retest of 103 individuals previously classified as infected, 3 had become negative, 33 immune, and 69 were still classified as infected. Of the 84 retested in the immune group, 80 retained the same classification and 4 were classified as infected.

The allergic response to four different dilutions of Brucellergin was compared in 185 Brucella-sensitive individuals. When a dilution of Brucellergin higher than 1:2,000 was employed, a slight decrease was noted in its activity.

The 1:2,000 dilution should always be used for diagnostic purposes, but for epidemiological surveys in the general population, a dilution of 1:25,000 may be employed with a high degree of accuracy.

A Rapid Method for Determining the Permanent Wilting Point and for Indicating Under Field Conditions the Relation of Soil Moisture Thereto.—Bouyoucos, G. J.—Soil Science, 45:47-55. 1938. (Journal Article No. 310 (n. s.) from the Michigan Agricultural Experiment Station.)—A simple practical method is described for determining the permanent wilting point of soils and for indicating, under field conditions, whether the moisture is at, above or below this point. It is called the "cohesion method". Its principle is based upon the fact that when the moisture content of the soil is at or above the wilting point the moisture film around the soil particles is sufficiently thick to cause the soil particles or granules to stick to one another and to a spatula when the latter is lightly pressed against the soil mass, and to lift on or with the spatula as a pressed soil bar. When the soil moisture, however, is below the wilting point the moisture film is too thin and discontinuous and is held by the soil with too great attraction to bring about these results. The cohesion that takes place in this test is due to the water films and not to the natural stickiness of the soil.

The principle of the method is well supported by the phenomena of vapor pressure, freezing point depression, rate of evaporation, surface force, and energy changes, wherein it is shown that the curves of those phenomena undergo a pronounced change in the region of the wilting point.

The cohesion method for determining the wilting point of soils has been compared with the direct and with the dilatometer methods, and it has been found to be sensitive and accurate on practically all soils investigated except very sticky clays, the sieving of which and the resultant distribution of the moisture on all the soil particles of which, are very difficult.

This cohesion method can also be used under field conditions to ascertain whether the field moisture is at, above, or below the wilting point.

The Detection of Antigenic Variants of Brucella by Means of an Opsonocytophagic Test.—Munger, Myrtle and Huddleson, I. F.—Jour. Bacteriology. 35(3): 255-260. 1938. (Journal Article No. 312 (n. s.) from the Michigan Agricultural Experiment Station.)—The most satisfactory method for detecting an antigenic variant culture of Brucella is an opsonocytophagic test conducted with citrated normal whole blood from humans or guinea pigs. The bacterial cells of an antigenic variant culture are phagocytized in large numbers by the polymorphonuclear cells in citrated normal whole blood from humans and guinea pigs. Bacterial cells of a normal culture are phagocytized slightly, if at all, by leukocytes in citrated normal blood of the same species. Antigenic variants of Brucella are unsuitable for use in the opsonocytophagic test for detecting specific Brucella opsonins in blood of human beings or animals.

The Idea of the Natural Land Type.—Veatch, J. O.—Proc. Soil Sci. Soc. Am. 2:499-503. 1937. (Journal Article No. 315 (n. s.) of the Michigan Agricultural Experiment Station.)—The idea of differentiating land surfaces into natural divisions which are complexes, or associations, of soils and relief features is discussed. The name *pedonomorphic* for such divisions is proposed. On the basis of a critical study of the soil survey maps of the United States Bureau of Chemistry and Soils the conclusion is reached that the soil types as at present differentiated may be regarded in part as minor natural land types, but that the same soil type is not everywhere the same land type. The natural land type is more inclusive of the natural factors, which influence the use and value of land, than is the soil type alone.

Boron Deficiency in Michigan Soils.—Cook, R. L.—Soil Sci. Soc. Am. Proc. 2:375-382. 1937. (Journal Article No. 316 (n. s.) from the Michigan Agricultural Experiment Station.)—During the 1936 and 1937 field plat experiments with sugar beets and in the course of certain pot culture experiments with several crops, characteristic boron deficiency symptoms were established for sugar beets, alfalfa, red clover, alsike clover and sweet clover. Certain physiological disorders observed in sugar beets in Michigan were the same as those described by certain other investigators as heart rot caused by boron deficiency. Attempts at field control were not successful but as much as 80 pounds of borax was applied per acre, broadcast, without injury to the beets in 1937.

In the greenhouse, increased yields of alfalfa and alsike clover resulted from applications of small quantities of sodium tetraborate. Some of the leaves of plants growing on boron deficient soils turned red and bronze at the blossom stage. Within a few days after turning red the leaves turned yellow and soon died. Red clover and sweet clover responded similarly to boron treatments but the reddening of the leaves was less apparent in the sweet clover. No response was obtained from applications of sodium tetraborate to sand cultures planted to barley, beans and corn.

In the field boron deficiency in alfalfa occurred in patches and was particularly prevalent in the areas where heart rot of sugar beets was serious. It was further noticed that in fields of mixed alfalfa and clover the symptoms, when present, invariably occurred on both crops.

It is concluded that a considerable aggregate of Michigan soils is

deficient in boron for sugar beets and the leguminous crops, but the economic seriousness of the deficiency can only be determined by further soil tests and field research.

Relation of Number of Seeds to Fruit Size and Shape in Cucumbers.— Seaton, H. L.—Proc. Am. Soc. Hort. Sci. 35:654-658. 1937. (Journal Article No. 317 (n. s.) from the Michigan Agricultural Experiment Station.)—Highly significant differences were found in the weight, length of fruit, length of seed cavity and numbers of fully developed and aborted seeds in the constricted portions between normal and constricted fruits of the National Pickling cucumber. There was a close relationship between the number of fully developed seeds, and the extent of development of the surrounding fleshy tissues. This relationship between seed development and tissue development suggests that pollination may be involved. It has been found that under one set of conditions a large percentage of the flowers produce straight fruits while the next day under altered conditions fully 90 per cent of the ovaries may develop into fruits with stem-end constrictions and under slightly different conditions an equal percentage of the ovaries will develop into fruits with blossom-end constrictions.

Co-operation as a Culture Pattern Within a Community.—Hoffer, C. R.—Rural Sociology. 3(2):153-158. 1938. (Journal Article No. 331 (n. s.) from the Michigan Agricultural Experiment Station.)—A study of a comparatively old, well-established Michigan community showed that co-operation, either of a formal or informal type, had developed as a culture pattern in the community. Residents applied the method of co-operation in numerous ways as occasion demanded. They organized (a) a county Holstein-Friesian Association, (b) a Dairy Herd Improvement Association, (c) a farmers' co-operative association, and (d) a county veterinary service. The more informal activities included the establishment of a community hospital, a public library, the organization of charities and the promotion of various projects to create friendly relationships between the town and its trade area. The development and use of the co-operative method in this community occurred without special or unusual stimulation from outside agencies. This suggests that, although urbanization as well as state and national groups have increased in importance in recent decades, local communities may still maintain a considerable degree of autonomy in the formation of their culture patterns.

The Bulletins of this Station are sent free when available to such individuals as may request them. Please request only those actually needed. Address all applications to the Director, Agricultural Experiment Station, East Lansing, Michigan.

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MICHIGAN AGRICULTURAL EXPERIMENT STATION QUARTERLY BULLETIN
Volume XXI, Number 2, November, 1938

FEEDING AND CONFINEMENT REARING EXPERIMENT WITH TURKEYS DURING 1937

(Third Report)

F. N. BARRETT, C. G. CARD, AND ASHLEY BERRIDGE
SECTION OF POULTRY HUSBANDRY AND LAKE CITY EXPERIMENT STATION

Rearing turkeys under confinement conditions demands a diet that is carefully balanced and that will adequately meet the requirements of the bird for body maintenance, growth and reproduction. In the development of suitable rations many factors must be considered, such as—palatability, normal development of body and feathers, rate of growth, health, vigor, physiological effect, finish, egg production, hatchability, availability of ingredients, ease of management, and feeding economy. Ration 7 has demonstrated its superiority over previous mashes in the foregoing respects and is now used as a check ration in the feeding trials, as well as being the one recommended to growers who wish an excellent all-purpose mash. A complete account of the work of the 1935 and 1936 seasons was reported in the Michigan Agricultural Experiment Station Quarterly Bulletin, Vol. 19, No. 1 (August 1936) and Vol. 20, No. 1 (August 1937).

1937 Objectives

As in the previous year, the 1937 feeding trials were mainly concerned with the lowering of feeding costs without limiting the development of the birds. The approach to this objective was made with rations 8, 11, and 12. Rations 8 and 11 are similar in that neither contains dried milk products and that both include corn gluten meal. In the 1936 trials, ration 8 produced relatively poor early growth accompanied by gray and rough feathering which apparently was due to a deficiency of vitamin G. Ration 11 is an attempt at correcting this condition by the addition of fish meal. Ration 12 was used in combination with ration 7 to answer the question as to the economy of using a ration relatively low in protein, after the eighth or twelfth week, with poults started on a high-protein ration. To meet the need for a ration in which barley completely replaced corn, both in the mash and grain part of the diet, ration 10, which is identical with ration 7 except for this substitution, was included in this year's feeding trials. The rations that were used and also the protein content of the mashes are shown in Table 1.

Incubation and Starting Methods

The poults used in these trials were hatched at the poultry laboratory at East Lansing from eggs produced by the breeding flock of Bronze turkeys at the Lake City Experiment Station. The first trial was made

Table 1. Rations.

RATION	7	8	10	11	12
PROTEIN CONTENT OF MASH	27%	25%	27.5%	28.5%	18.0%
Ground yellow corn	10	15	—	10	30
Ground barley	—	—	10	—	—
Ground oats	15	16	15	15	23
Wheat bran	10	13	10	13	20.5
Wheat flour middlings	10	12	10	13	—
Corn gluten meal	—	10	—	10	—
Meat scraps	14	10	14	10	6
Fish meal	—	—	—	10	—
Soybean oil meal	22	15	22	10	6
Dried skimmilk	10	—	10	—	6
Alfalfa meal	5	5	5	5	5
Calcium carbonate	1	1	1	1	1.5
Steam bone meal	—	—	—	—	1
Salt	1	1	1	1	1
***Cod liver oil	2	2	2	2	—
TOTAL	100	100	100	100	100
To drink	Water only	Water only	Water only	Water only	Water only
*Grain	Corn	Corn	Barley	Corn	Corn
**Green feed	Chopped Alfalfa	Chopped Alfalfa	Chopped Alfalfa	Chopped Alfalfa	Chopped Alfalfa
*Grit	Gravel	Gravel	Gravel	Gravel	Gravel

*Grain and gravel were added to the diet at the end of the seventh week.
**Chopped fresh alfalfa was given daily from the third week through the remainder of the experiment.
***Cod liver oil was discontinued after the sixteenth week.

with poults hatched May 7, with the exception of the combination ration 7-12 in which case poults hatched May 26 were used. A second trial was made with poults hatched May 26, except for those poults that were used with ration 7-12, which were hatched June 11.

The young poults were removed from the incubator when dry and placed in baby chick shipping boxes for the first 24 hours. At the end of that time they were placed under small brooders in the laboratory building in lots of about 40 poults each. Mash in hoppers, together with water in vacuum fountains, was the only food given for the first week, with the exception of a small amount of hard-boiled egg which was added to the diet during the first five days. Burlap was used for a floor covering for the first three or four days, until the poults were accustomed to eating mash, after which time fine shavings were used until the birds were removed to Lake City.

Experimental Pens at East Lansing

At the end of the first week the poults were sorted into experimental lots of 30 each. Each lot was provided with an indoor pen, 4½ feet wide and 10 feet long, with an electric hover. Perches were added when the hovers were no longer required.

Because the poults for the second trial were hatched about three weeks later than those of the first trial, it was necessary to remove the first lot to quarters in a laying house to give the preferred location in the laboratory to the younger birds. The birds remained in these quarters until removed to Lake City at the end of the seventh week.

The poults of the second trial remained in the quarters first mentioned until the end of the sixth week. With each trial it was necessary to keep the poults under the conditions described until their age and the weather conditions made it possible to transfer them to the large, open, turkey house at Lake City.

The Lake City Turkey House

At the Lake City Station, each lot of 30 turkeys was confined to a pen 10 feet wide and 24 feet deep in the open-front turkey house. This building, which is 100 feet long, is constructed of rough lumber and poles. The house is divided into 10 pens with wire and wood partitions. At the end and back walls are hinged panels that may be opened for summer ventilation. At the rear of each pen are perches and a dropping board. The floors are of concrete, and straw was used for litter.

Feeding Plan

In both trials, each of four of the pens of turkeys had its own distinct mash which was used for the entire period, and these are reported as Rations 7, 8, 10 and 11, respectively, and correspond to the mash formula number. The remaining pen, in each trial, received a combination of two mashes. In the first trial these birds were fed mash 7 until the end of the eighth week when a change was made to mash 12, and the pen was continued on this mash for the remainder of the 24 weeks. In the second trial, mash 7 was fed until the end of the twelfth week when a change was made to mash 12 for the remainder of the period. The two pens receiving this combination are reported as ration 7-12. Mash, gravel and water were before the birds at all times at Lake City, and grain was similarly provided for all pens after the first seven weeks. All pens received corn as the grain part of the ration with the exception of ration 10 which had only whole barley. Chopped fresh alfalfa was given daily in slatted racks.

Presentation of Results

Amount of Grain Consumed Influenced by Protein Content of Mash— Low protein mashes, which usually cost less per ton, do not necessarily produce cheaper gains than the somewhat more costly, high-protein mashes. When given a free choice there is a definite tendency for the birds receiving mashes of low protein content to consume a greater proportion of the mash and less of the grain than with mashes of the higher protein levels. There is also a natural tendency for turkeys to consume an increasing proportion of grain as they approach maturity. These tendencies are indicated by the data presented in Table 2.

Feed Consumed per Pound of Gain—One of the measures of the efficiency of a diet is the proportion of mash and grain, as well as the total quantity of these ingredients that is required to produce a unit of gain in weight in the birds. The average amount of feed consumed per pound of gain is given in Table 3.

Table 2. Proportion of mash and grain consumed.*

(Total mash and grain consumed equals 100)

Ration	Trial	0-4 Weeks		5-8 Weeks		9-12 Weeks		13-16 Weeks		17-20 Weeks		21-24 Weeks	
		Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain
7......	1......	100	0	97.5	2.5	86.7	13.3	75.8	24.2	64.0	36.0	46.0	54.0
	2......	100	0	100.0	0.0	99.5	0.5	99.9	0.1	94.3	5.7	54.0	46.0
8......	1......	100	0	92.8	7.2	90.6	9.4	83.2	16.8	73.9	26.1	60.7	39.3
	2......	100	0	99.0	1.0	100.0	0.0	94.4	5.6	70.3	29.7	44.3	55.7
10......	1......	100	0	91.3	8.7	84.8	15.2	68.7	31.3	52.1	37.9	40.0	60.0
	2......	100	0	100.0	0.0	76.7	23.3	56.3	43.7	34.2	65.8	18.7	81.3
11......	1......	100	0	98.2	1.8	89.2	10.8	77.0	23.0	60.9	39.1	42.1	57.9
	2......	100	0	100.0	0.0	99.1	0.9	85.4	14.6	60.1	39.9	33.5	66.5
7–12...	1......	100	0	100.0	0.0	99.9	0.1	96.9	3.1	81.5	18.5	55.9	44.1
	2......	100	0	100.0	0.0	98.1	1.9	88.4	11.6	76.3	23.7	54.8	45.2

*Mash in hoppers from the start. Grain in hoppers after the seventh week until the end of the period.

Average Cost of Producing a Pound of Gain—In determining the merit of any ration, the cost of producing a unit of gain should be considered. This information is given for each trial and for each ration in Table 4. Consideration should also be given to the normal development of the bird, the growth rate, physiological effect of the diet, the character of the finished product, and any other advantage or disadvantage of the particular ration before definite conclusions are drawn. Feed costs vary from one year to another because of changing feed prices. The price of feeds during the 1937 season while relatively high, was about 10 per cent lower than the previous year. This resulted in a corresponding lowering in the cost of producing a pound of gain.

Table 3. Pounds of feed consumed per pound of gain.

Ration	Trial 1					Trial 2				
	7	8	10	11	7-12	7	8	10	11	7-12
Mash....................	2.94	3.16	2.68	2.73	3.91	4.18	3.23	2.45	3.02	3.65
Corn....................	1.32	.94	—	1.33	.92	.71	1.04	—	1.38	1.06
Barley..................	—	—	1.69	—	—	—	—	2.51	—	—
Mash and grain total......	4.26	4.10	4.37	4.06	4.83	4.89	4.27	4.96	4.40	4.71

1937 Feed Prices—The prices paid for the different mashes and grains are shown in Table 5. The relatively low cost of ration 8 is due largely to the addition of corn gluten meal and the elimination of dried milk. Ration 11 is the result of modifying ration 8 with a fish meal addition, to correct certain basic faults, and this accounts for the difference in

Table 4. Feed cost per pound gain.

Ration	Trial 1					Trial 2				
	7	8	10	11	7-12	7	8	10	11	7-12
Mash	$.076	$.071	$.070	$.068	$.084	$.109	$.073	$.064	$.076	$.082
Corn	.023	.016	—	.023	.016	.012	.018	—	.024	.019
Barley	—	—	.024	—	—	—	—	.035	—	—
Mash and grain total	$.099	$.087	$.094	$.091	$.100	$.121	$.091	$.099	$.100	$.101

price of these otherwise similar rations. The low cost of ration 12 is due primarily to a material reduction in protein supplements. The substitution of barley for the corn in mash 7 created mash 10 but with no change in price.

Table 5. Feed price.

Ration	Trial 1					Trial 2				
	7	8	10	11	12	7	8	10	11	12
Mash (ton)	$52.00	$45.00	$52.00	$50.00	$42.00	$52.00	$45.00	$52.00	$50.00	$42.00
Corn (bu.)	.98	.98	—	.98	.98	.98	.98	—	.98	.98
Barley (bu.)	—	—	.67	—	—	—	—	.67	—	—

Growth Rates—The average weights of both male and female turkeys at the end of the four-week periods are given in Table 6. The rate of growth of the different groups may be noted from the data presented.

Table 6. Growth of turkeys.
(Average weight in pounds)

Ration	Trial	4 Weeks		8 Weeks		12 Weeks		16 Weeks		20 Weeks		24 Weeks	
		M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
7	1	.80	.66	3.35	2.61	6.82	4.88	11.22	7.82	15.81	10.31	20.15	12.59
	2	.83	.75	3.30	2.83	6.59	5.08	10.76	7.93	14.54	10.32	19.03	12.25
8	1	.63	.61	2.69	2.41	5.62	4.84	9.54	7.83	13.60	10.59	17.65	12.86
	2	.78	.74	2.96	2.58	6.29	5.09	10.79	8.23	15.25	10.99	18.76	13.08
10	1	.74	.68	3.04	2.52	6.45	4.97	10.71	7.92	15.06	10.44	19.06	12.45
	2	.81	.80	3.00	2.70	6.28	5.26	10.60	8.23	15.08	10.82	19.08	12.33
11	1	.71	.69	2.91	2.67	6.09	5.19	10.38	8.14	14.86	10.57	18.74	12.76
	2	.80	.81	3.18	2.87	6.59	5.73	11.02	8.50	15.42	10.95	19.24	12.68
7-12	1	.69	.65	2.63	2.36	5.33	4.83	8.76	7.70	12.64	10.40	16.33	12.30
	2	.61	.60	2.52	2.21	5.90	4.78	9.95	8.00	14.62	10.65	18.29	12.48

Mortality—A total of 278 turkeys completed the 24 weeks of the feeding trials in good marketable condition out of 314 birds that were started. The total loss from all causes was 36 birds or 11.5 per cent, and this includes birds accidentally killed, stolen, or those removed because of injury or serious defect. Most of this loss occurred during the first few weeks and the loss after the twelfth week was negligible.

Observations—In the 1937 trials, ration 7 continued to give outstanding results throughout the entire feeding period. The birds were vigorous at all stages of growth and the feathering was smooth, lustrous and richly colored. The turkeys on ration 7 in the second trial, for some unexplained reason, consumed a greater amount of mash and a lower proportion of grain than is normal with this diet. The relatively small proportion of grain that was consumed, by this pen, during the first 20 weeks resulted in a higher cost per pound of gain than is usual with this ration. Ration 10, which is a modification of ration 7 with barley replacing the corn in both mash and grain, appeared to give equally as good growth, feathering and finish as ration 7.

During the 1936 trials, ration 8 gave unsatisfactory early growth which was accompanied by rough, dull, gray, weak-colored plumage. During 1937 this ration gave more satisfactory early growth and feather characteristics, but gray feathering was general by the fourth week. The analysis of the protein content was reported as 22 per cent in 1936 and as 26 per cent in 1937. Ration 11, which is essentially the same as ration 8 but for the addition of fish meal, gave very satisfactory results in growth and plumage characteristics in both trials and compared favorably with the best rations.

Ration 12 has a relatively low protein content and is typical of the usual chick growing mashes. Although low in cost this ration did not tend to produce such economical gains or such good finish, when fed after the eighth or twelfth week to poults started on ration 7, as did the ration fed the birds on the higher protein mashes.

There were very few cases of pendulous crop or crooked keels and these were not significant on any one diet.

Table 7.

Ration	Trial 1					Trial 2				
	7	8	10	11	7-12	7	8	10	11	7-12
Birds started	30	30	30	30	43	30	30	30	30	31
Surviving birds	28	25	30	28	37	27	27	22	26	28
Total weight	446.3	410.1	479.9	451.3	507.9	428.3	449.8	335.2	423.5	427.1
Number of males	10	14	16	14	13	14	15	4	13	13
Heaviest male	22.1	21.3	21.5	20.8	17.5	21.4	20.9	20.9	21.0	20.6
Lightest male	17.8	15.1	14.5	17.1	13.8	16.8	16.3	16.9	17.4	15.4
Average weight	20.15	17.65	19.06	18.74	16.33	19.03	18.76	19.08	19.24	18.29
Number of females	18	11	14	14	24	13	12	18	13	15
Heaviest female	14.8	15.5	16.4	14.8	14.0	13.4	14.2	13.8	13.7	15.0
Lightest female	10.0	11.5	11.0	11.6	10.3	10.0	12.0	9.3	11.4	11.1
Average weight	12.59	12.86	12.45	12.76	12.30	12.25	13.08	12.33	12.68	12.48

Final Weights—There were 278 turkeys that completed the feeding trials in good marketable condition. The turkeys on rations 7 and 10 were the outstanding birds as far as quality and finish were concerned. The turkeys on ration 11 were close to the best. Ration 8 produced birds that would rate fair to good. The turkeys on the ration 7-12 combination were good but lacked the best finish. There were only a few cases of crooked breasts and these were not significant on any one diet. The final weights of both male and female turkeys are given in Table 7.

Average Weekly Weights of Bronze Turkeys

These weights which are given in Table 8 are based on the results of six separate feeding trials conducted during 1935, 1936, and 1937 and include all turkeys surviving the 24-week period. The turkeys were reared under confinement during the brooding period at East Lansing and later in the open-front turkey house at the Lake City Experiment Station.

Mash 7 was hopper-fed during the entire period and corn was available for the birds at all times after the eighth week of age. Chopped alfalfa was given daily from the third week to the end of the trials. The birds had only water to drink. Gravel was provided for grit.. Cod liver oil was discontinued in the mash after the sixteenth week.

Table 8. Average weekly weight of Bronze turkeys.

(3 years results)

Age in Weeks	Average Weight per Bird	Average Weight of Males	Average Weight of Females
1	.18	.18	.17
2	.29	.30	.27
3	.46	.48	.43
4	.71	.76	.66
5	.98	1.13	.83
6	1.50	1.62	1.38
7	2.14	2.30	1.97
8	2.78	3.01	2.55
9	3.39	3.70	3.07
10	4.10	4.51	3.68
11	4.79	5.34	4.24
12	5.59	6.25	4.93
13	6.46	7.21	5.71
14	7.28	8.20	6.35
15	8.20	9.30	7.09
16	9.04	10.32	7.76
17	10.03	11.53	8.53
18	10.89	12.59	9.18
19	11.80	13.76	9.83
20	12.60	14.83	10.37
21	13.53	16.02	11.04
22	14.42	17.15	11.68
23	15.08	18.01	12.14
24	15.85	19.12	12.58

Average amount of mash and grain consumed per pound of gain:

Mash	3.11 lbs.
Grain	1.30 lbs.
Total	4.41 lbs.

A Cobblestone Turkey Yard—The first cobblestone turkey yard was constructed at the Lake City Station in 1937. It seems to offer a simple yet promising method of yarding turkeys for the control of Blackhead. This is a permanent yard, 75 feet square, and for convenience, adjacent to the main turkey house. It is provided with an inexpensive shelter which will accommodate from 75 to 100 turkeys to maturity. The yard proved so satisfactory during the first year that a second one of the same size was established in 1938.

The essential feature of the yard is that the ground is covered with stones that vary in size from one to three inches in diameter. A three- or four-inch layer of these stones is spread over the lot so that the

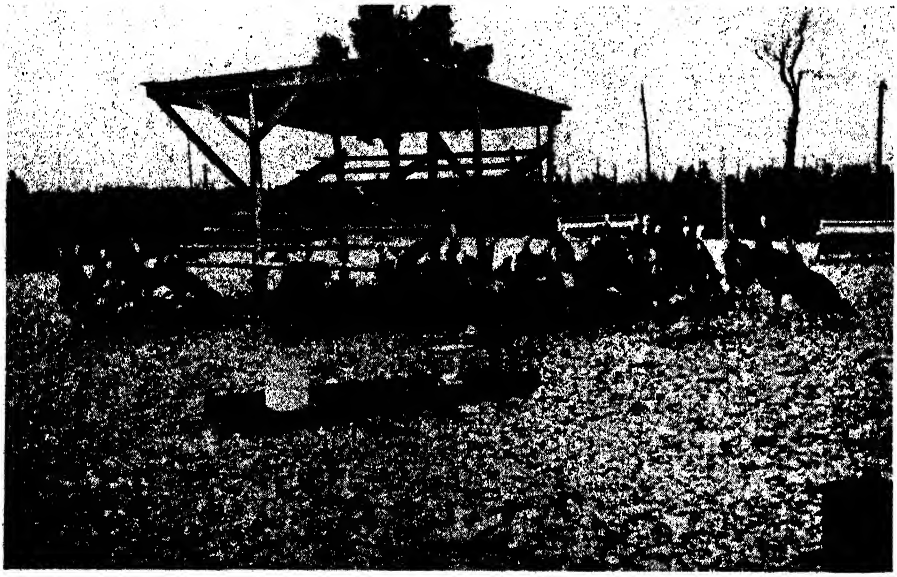

Fig. 1. Cobblestone yard and cheap summer shelter.

turkeys do not come in contact with the surface soil. Each rain washes off the droppings and the yard looks clean, even during the summer months when rains are less frequent. The turkeys also have clean feet. Each spring the stones are loosened with a spring-tooth harrow and occasionally more stones may be added. The stones are obtained from a gravel pit and are the larger screenings that are rejected in the production of road gravel. They usually can be had for the hauling. A view of such a yard is shown in Fig. 1.

Summary

There is a definite tendency for turkeys on low-protein mashes to consume a greater proportion of the mash and a smaller proportion of the grain than is the case with the higher protein mashes.

There is a general tendency for turkeys to consume a greater pro-

portion of grain and a smaller proportion of mash as they approach maturity.

Ration 7 continues to produce thrifty turkeys with smooth, lustrous, plumage and excellent market quality. This is recommended as an excellent all-purpose mash for starting baby poults and for the development of turkeys of excellent quality at moderate cost.

Ration 10 may safely be recommended to the barley farmer who wishes to substitute barley for corn in both mash and grain. It is a modification of ration 7 and is similar to this ration in essential ingredients and results.

Ration 8 is not suitably balanced for the most satisfactory development of birds and is not recommended. It is especially undesirable as a starting ration and also tends to be constipating. Although ration 11 apparently gave satisfactory growth and finish this first year, it will not be generally recommended without further trials.

As a result of this year's work it would appear that there is little if any economy or advantage in feeding a low-protein mash, similar to a chick growing mash, to turkeys after they have been started for the first eight or twelve weeks on a high-protein ration.

FROST HARDINESS OF SOME TREES AND SHRUBS FOR FOREST PLANTING IN SOUTHERN MICHIGAN

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SECTION OF FORESTRY

The late spring frosts which occurred through southern Michigan on May 12 and 13, 1938 provided an excellent test of the frost hardiness of various tree and shrub plantings made on the Kellogg reforestation tract of Michigan State College. This tract is located in Kalamazoo County, eight miles northwest of Battle Creek, Mich., and near the town of Augusta. Conditions are probably typical of southern Michigan.

Weather during the spring period was somewhat abnormal. An unusually warm period occurred during latter March, causing the swelling of buds and the beginning of new growth by a number of species. Intermittent periods of cool and warm weather allowed a gradual advance of growth until by May 12 many of the species were well in leaf.

Weather bureau data at Battle Creek, and at the Kellogg farm two and one-half miles from the reforestation tract show that temperatures of 28° F. occurred on May 12 and again on May 13. Because the reforestation tract is located partly in the valley of Augusta Creek, temperatures there were lower than 28° F. Unofficial records indicate that valley temperatures of 25° F. and 26° F. occurred on May 12 and 13. It is well known that cold air drainage often causes temperatures in low areas to be lower than on adjacent higher areas. No killing frost occurred during the spring after May 13.

While the season may be considered abnormal, it does not represent an entirely unusual condition. Damaging late spring frosts occur periodically and may be expected to occur during certain years. Trees must be adapted to withstand such frosts in order to be used successfully in forest plantations. It is the extreme conditions such as late spring frosts that determine the suitability of a species for growth in a given locality or region.

Observations on frost hardiness were made on 47 different species of forest trees and shrubs planted on the tract. Most of the plantations were young, having been planted as small seedlings or transplants during the period 1935-37. The oldest plantations date back to 1931-32.

Amount of frost damage was classified under three categories as follows:

(1) **Damage None or Slight**—Species in this category proved resistant to frost damage under all conditions and showed little or no killing of leaves or other tissues.

(2) **Damage Moderate**—In this group species showed some damage by frost, especially on low sites. From 25 to 50% of new leaves and opened buds or succulent growth were killed.

(3) **Damage Heavy**—Practically all new growth and opened buds of species in this group were killed. Damage was severe even on the higher sites. In some cases older growth, woody tissues one or several years old, was killed.

On the basis of these three categories the species may be classified as (1) frost hardy, (2) moderately frost hardy, and (3) not frost hardy. This classification has particular reference to frost hardiness of the species considered here during the early spring growing period. It should not be taken to mean that species classified as "not frost hardy" can not be grown successfully in this region. In fact, once established, all of these species will grow reasonably well in southern Michigan.

In Table 1 the 47 species of trees and shrubs studied at the Kellogg reforestation tract are classified according to frost hardiness.

Table 1. Frost hardiness of trees and shrubs at Kellogg reforestation tract.

Frost Hardy	Moderately Hardy	Not Frost Hardy
Russian olive	white spruce	black walnut
Siberian pea tree	Macedonian pine	butternut
tamarack	European larch	red oak
red maple	pin cherry	white oak
sugar maple	mountain ash	black locust
wild plum	black cherry	honey locust
red osier dogwood	basswood	white mulberry
Scotch pine	Chinese elm	American chestnut
red pine	Amur river privet	hackberry
jack pine	cornelian cherry	northern pecan
Austrian pine	*hybrid poplars	*hybrid walnuts
northern white cedar	Norway spruce	English walnut
ponderosa pine	indigo bush	chinquapin
pitch pine		Douglas fir
red spruce		white ash
Japanese red pine		green ash
Nanking cherry		
Tartarian honeysuckle		

*Includes several species or varieties of similar frost hardiness.

Frost Hardiness Varies With Species

Frost hardiness varied considerably among the different species. Native conifers and hardwoods, particularly those whose natural range extends through northern Michigan, are among the frost hardy. Also included in this group are species introduced from regions having climates as severe as or more severe than the climate of central Michigan.

Moderately hardy species include some of the native hardwoods along with a number of exotic introductions and several native species: white spruce, mountain ash, and pin cherry, whose principal ranges are farther northward.

In the "not frost hardy" group are many species introduced from central United States along with some of the less hardy native hardwoods, a few hybrid species and one conifer from western United States. Though species varied greatly in frost hardiness, the extent of variation within a species appeared to be slight.

Native species growing naturally on low sites in Michigan were among the most frost hardy species. Tamarack, red maple, northern white cedar and red osier dogwood are such species.

Foliage of the indigo bush was frozen back completely wherever it appeared, but for the most part buds of this species had not opened, and damage as a consequence was very slight. The opening of the buds at such a late date in this species resulted in its classification as fairly hardy. In relation to resistance of the foliage to freezing it would be classified as not hardy. Walnut and butternut buds had just begun to open at the time of the frosts. Practically all one- and two-year seedlings of these species were killed back to the ground. Year-old wood was killed in the case of older trees of these species.

European larch with leaves only slightly elongated proved very resistant to frost damage, but trees with advanced foliage growth were severely damaged, and in some cases the trees were killed.

Douglas fir appeared particularly susceptible to late spring frosts. About 75 per cent of the new shoots were killed, and approximately 20 per cent of the trees died as the result. Trees in many cases were weakened, necessitating additional care to ensure their survival. A variety of Douglas fir which would begin growth later in spring therefore would be much better adapted for southern Michigan conditions.

Most of the conifers, especially the pines, were frost hardy, although some damage did occur. Occasional buds or new growth on white pine appeared dried or shriveled. Growth of damaged shoots was usually stunted; the more severely damaged shoots were killed and later turned black. The same occurred to a considerable extent with the introduced Macedonian pine. When the first new shoots were frozen, only weak, adventitious shoots were formed to take their place.

Occasionally the first needles to appear from the opening buds of red and Scotch pine were killed by the frost, but the main shoot remained undamaged. Thus the upper part of the leader in these species would be bare of needles, or the needles would remain very short in contrast with the normal length of the needles not damaged by frost.

Frost Hardiness Due to Several Factors

In some species frost hardiness appeared due to the ability of new growth to resist freezing. Sugar maple, red maple, Russian olive, Siberian pea tree, tamarack, and red osier dogwood, for example, had well developed leaves at the times when the frosts occurred. Yet the leaves were not damaged.

Frost hardiness in other species seemed to be due to the late opening of the buds. Of red, Norway, and white spruces, red spruce alone escaped injury because the buds were just beginning to open at the time of the heavy frosts, whereas Norway spruce and white spruce, with many buds opened and advanced growth appearing, suffered extensive freezing back of succulent growth. Norway spruce, however, suffered more severely than white spruce, the succulent growth of the former apparently being more susceptible to frosts.

Thus frost hardiness as here considered is due either to the ability of new growth to resist freezing or ability of the plant to escape the late frosts by remaining in the winter dormant condition until danger from frosts is over.

Topography Influences Severity of Frost Damage

Frost damage was found to vary greatly between ridge and valley sites, being much more severe on valley sites. In general, the lower the elevation, the more severe was the frost damage. Upper slopes and ridges showed relatively little damage as compared with lower slopes and valleys. Basswood and oak, for instance, had all foliage completely killed on valley and lower slope sites, but slight damage occurred on middle and upper slopes.

It seems probable that failure of black walnut, red oak, basswood, Douglas fir and Norway spruce to effect good establishment on low sites at the Kellogg reforestation tract has been due largely to repeated frost damage.

Summary

A study was made of frost hardiness of forty-seven species of forest trees and shrubs at the Kellogg reforestation tract.

Species were classified in three categories as (1) frost hardy, (2) moderately frost hardy, and (3) not frost hardy.

Species were found to vary considerably in frost hardiness.

Frost hardiness was observed to be due in some species to resistance of new growth to freezing. In others it was due to late opening of buds, thus avoiding exposure of new growth to frosts.

Severity of frost damage varied considerably according to topography, being much more severe on lower slopes and valley lands than on upper slopes and ridges.

Frost damage may deform, weaken or kill forest tree and shrub plantings. Establishment may be delayed or prevented. Additional care may be required to ensure survival of damaged trees because of competition from other plants.

For best results in forest plantings, only frost hardy trees should be planted on low sites where danger from frosts is great and plantings of species not frost hardy should be limited to upper slopes and ridges where there is less danger from frosts.

GROUND ALFALFA VS. TANKAGE FOR SOWS

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Section of Animal Husbandry

Ground alfalfa was compared in efficiency and cost with tankage as a supplement to corn for brood sows during the gestation period. Four trials were completed in successive seasons from December 1932 to the spring of 1936.

The sows and gilts were divided as evenly as possible into two lots considering age, breeding, development, and in the case of the older sows, previous production records. Gilts bred to farrow their first litters at one year of age and thinner or timid sows were fed separately. The daily feed allowance was regulated so as to bring the sows into ideal condition at farrowing time.

Choice quality second-cutting alfalfa hay was ground and mixed with ground grain for the alfalfa lot in the proportion of one part of alfalfa and two parts of grain, while the other lot received approximately 6 per cent of tankage with their grain. Corn was the only grain used in the last three trials. A grain mixture of two parts corn and one of oats was used in the first trial. Both lots were given access to a rack of alfalfa hay of the same quality as the ground alfalfa, and had before them a mineral mixture of equal parts of limestone, bone meal and salt. The grain mixtures with ground alfalfa and tankage were hand-fed in an effort to produce the same rate of gain and condition of flesh for similar age groups of both lots.

The average rate of gain, feeds consumed, and cost computed on a 114-day basis are given in Table 1. The sows and gilts receiving ground alfalfa with their grain consumed from the rack 36 pounds of hay per sow, while those receiving the tankage consumed only 43 pounds of hay. The tankage-fed lot gained 0.14 pound more per sow daily. More total feed was required by the alfalfa-fed lot. The 243 pounds

Table 1. Gains and feed required by sows during their gestation period.

	Tankage	Alfalfa
Number of sows and gilts	63	59
Average daily gain	1.08 lbs.	.94 lbs.
Average weight at farrowing	507 "	506 "
Feeds consumed (114 days) per sow:		
Corn	604 "	486 "
Tankage	39 "	....
Ground alfalfa	....	243 "
Alfalfa hay	43 "	36 "
Oats	60 "	59 "
Bran	6 "	....
Minerals	6 "	7 "
Feed cost per sow	$7.42	$6.93

of ground alfalfa fed to them replaced 119 pounds of grain, 39 pounds of tankage, 6 pounds of bran, and 7 pounds of loose hay. Bran was fed to the tankage lot the last few days before farrowing to overcome a tendency toward constipation.

Feed prices charged were grain (corn, oats and bran) $20 per ton; tankage $45; alfalfa $7, plus $3 for grinding; and minerals 2 cents per pound. At these prices, the feed cost per head for the alfalfa lot was $6.93 as compared with $7.42 for the tankage lot, a saving of 49 cents per sow.

The pigs were individually marked, weighed and graded for apparent strength and vigor before they were 24 hours old. The average farrowing results are given in Table 2.

Table 2. Farrowing results.

	Tankage	Alfalfa
Number of pigs per litter	8.6	9.3
Number of strong pigs	6.2	6.4
Number of medium pigs	1.2	1.6
Number of weak pigs	.5	.6
Number of still-born pigs	.6	.7
Percentage of strong pigs	72.7	68.8
Percentage of medium pigs	14.2	16.6
Percentage of weak pigs	5.8	6.7
Percentage of still-born pigs	7.3	7.9
Weight per litter	23.4 lbs.	24.9 lbs.
Weight per pig	2.73 "	2.68 "

The slightly larger number of pigs produced per litter by the alfalfa-fed sows probably accounts for the small advantage in litter weight, and disadvantage in weight per pig. The advantage which the tankage-fed sows had in strength of pigs was undoubtedly due to the smaller litters produced by this group. Of the pigs produced by the alfalfa-fed sows, 85.4 per cent were strong or medium-strong as compared with 86.9 per cent strong and medium-strong pigs produced by the tankage-fed sows.

There is no material difference from the foregoing comparative results when the data for the mature sows is separated from that for the gilts farrowing their first litters at one year of age, except that the sows of both lots farrowed larger litters of heavier pigs than the gilts, but with more weak and still-born pigs. The gilts saved a larger percentage of their pigs until weaning time and weaned approximately the same number of pigs per litter as the sows, but their pigs gained slower, weighing nearly 10 pounds less at 56 days of age than those from the sows.

There was little difference in the apparent milking ability of the two lots of sows and gilts. Both lots of sows and their pigs received tankage as a protein supplement during the nursing period, since previous tests at this Station had shown very poor results when alfalfa was the only supplement used with corn and oats for nursing sows and young pigs.

These results indicate that second-cutting alfalfa hay of good quality may be used successfully as the only supplement to corn or corn and oats for sows and gilts during the gestation period. Corn was used in these trials in order to determine the practicability of supplementing a

low-protein grain with alfalfa. A variety of feed usually shows best results. It is, therefore, good policy when oats, wheat, or barley are as low in price as corn to feed a variety of grains to breeding animals.

ELECTRIC DAIRY WATER HEATER AND UTENSIL STERILIZER

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SECTION OF AGRICULTURAL ENGINEERING

Michigan's dairy industry produces a large part of the state's total farm income. This income could be increased by saving the thousands of dollars which are lost annually due to rejected milk—milk that is sour or off-flavor.

One of the great contributing causes of low-grade dairy products and sour milk is the unsterilized utensil. The bacteria which cause this souring, production of off-flavors and sometimes sickness multiply very rapidly on the moist surfaces of unsterilized pails, strainers and cans.

The demand for higher quality dairy products has caused many farmers to sterilize all of their milk handling equipment as an insurance against loss from souring or a low-grade product. That demand has stimulated an interest in hundreds of other farmers for an effective, low-cost electric sterilizer.

It should be remembered, however, that sterilization does not take the place of washing. Utensils which have not been properly washed commonly carry large numbers of bacteria in the particles of milk or butterfat which remain. Utensils are much easier to wash immediately after being used rather than letting the milk or cream to dry on the surface. They should first be rinsed with cold water. This prevents the milk solids from "cooking" on the utensils, reduces the amount of washing powder necessary and helps to keep the wash water clean. After thorough washing and rinsing in hot water, the utensil is ready for sterilization.

To have hot water available in the barn or milk house for washing of the utensils is a problem on many Michigan farms. Owing to the fire hazard associated with the use of an oil, wood or coal burning stove the water used for washing pails, cans and strainers is heated either on the kitchen stove or in an electric household water heater. This water may be efficiently hot to do a good washing job as it leaves the house but while being carried through the yard to the barn it rapidly loses its effectiveness.

To provide hot water (180° F.) at the place where it is to be used and further provide for effective sterilization of dairy utensils, the Agricultural Engineering Section has designed a portable combination electric water heater and sterilizer (Fig. 1).

This unit is a relatively simple piece of equipment, consisting of an 1,000- or 1,500-watt heating element which, except for the top heating

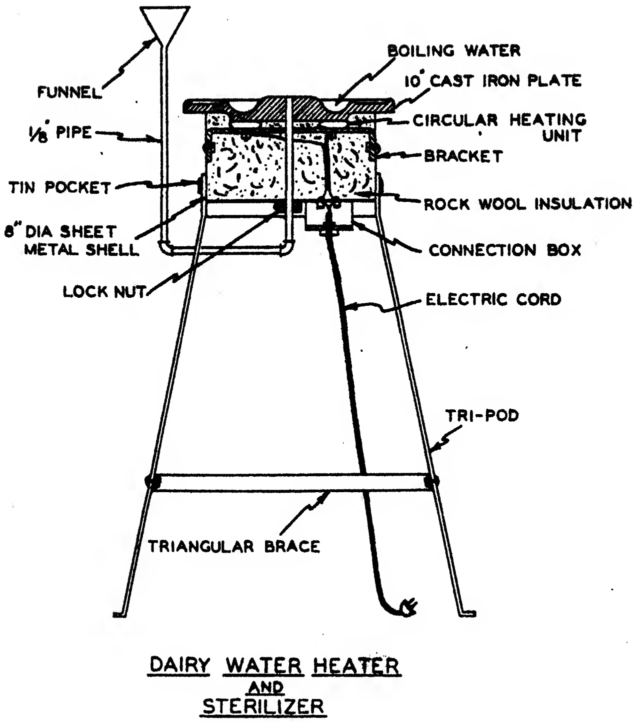


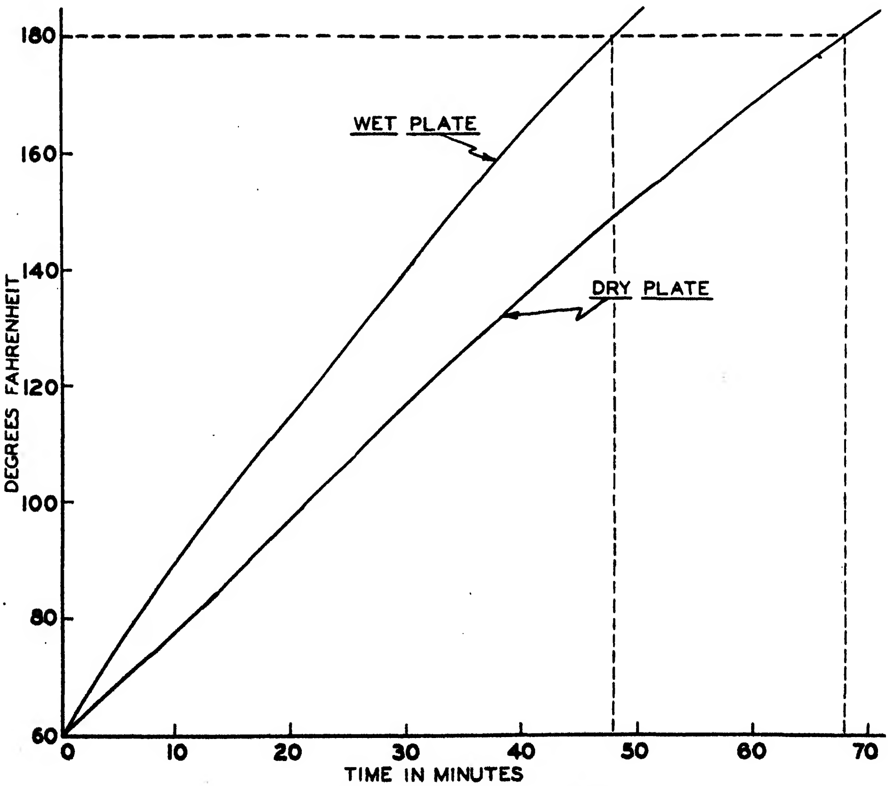
Fig. 1. Dairy water heater and sterilizer.

surface, is packed in fireproof insulation. A specially designed plate is placed over this element and fastened directly to it. This plate is one of the unique features of the unit.

Normally a heating unit is a flat plate over which a pan or pail of water is placed. This makes an effective medium provided the pan or pail has a perfectly flat bottom and makes a good contact with the heating element. The average farm pail, however, does not have a flat bottom, rather it is "dished" or may be otherwise bent. A pail with the bottom just described would not contact a heating plate in its entirety and would provide an air space between the heating plate and the area to be heated, thus effecting a layer of air insulation between the two which would decrease the efficiency of the heater by increasing the time necessary to heat the water. (Fig. 2.) To overcome this difficulty the heating surface or plate on this unit is designed with a circular depression which, in operation is filled with water. This water is rapidly heated and is converted to steam. The steam rises, contacts the cold surface of the pail and condenses. As the steam condenses, a drop of water is formed which drips back onto the heated plate and is again converted into steam. This process continues until the water in the pail is heated. The whole heater assembly may be mounted on tripod legs or may be built into a table.

The use of this heater fits perfectly into the operating routine of average farm dairy. Just before starting to milk, the dairyman

places approximately one-quarter pint of water in the depression built into the heating plate, places the pail of water which will later be used for washing purposes over the plate and turns on the current. The wash water is hot by the time the milking is done and the milk cooled (see Table 1). It is recommended, for efficient operation, that the pail be equipped with an insulated cover which may simply be a piece of ½" thick insulating board cut to fit the top of the pail. This cover should be strengthened and protected by the addition of galvanized sheet iron to either side of the insulating board. As the cans and pails are washed and rinsed they are inverted over the heated plate. A small amount of water is again placed on the plate by means of the funnel mounted on the side of the unit. This water is quickly converted to steam and fills the interior of the utensil with low-pressure, moist steam. With the 1,500-watt element the time required to raise the temperature of a 10-gallon can to 200° F. is about two and one-half minutes. With this unit it is easily possible to sterilize quickly cans and other dairy utensils immediately before milking, thereby eliminating a source of bacterial contamination.



TIME REQUIRED TO HEAT 8 QTS. OF WATER WITH A UNIT HEATER OF 1000 WATTS

Fig. 2. Time required to heat 8 quarts of water with a unit heater of 1000 watts.

Table 1. Time necessary to heat various quantities of water* 1000 watt heating element.

Amount of water in quarts	Time (Minutes) to heat from 60° to 180° F.	
	Insulated cover on pail	No cover on pail
2	9.5	10.5
4	22.0	25.8
6	34.0	39.0
8	48.0	54.5
10	63.0	77.0

*One-quarter pint water used on heating plate in all of above trials.

One of the chief objections to dairy equipment steam sterilizers of the past has been the high operating cost. This new development in sterilizers is efficient. Several experimental models have been under observation for some months; one in particular has been heating 2 gallons of water twice daily plus the sterilization of cans and mechanical milking equipment for an 18-cow dairy on a monthly kilowatt hour consumption of 52.8.

Milking machines and milk utensils properly washed and adequately sterilized on the farm with a safe, clean, odorless and efficient electric water heater and sterilizer will do much toward increasing the quality of milk. This quality will be reflected in increased demand which eventually will benefit the farmer financially.

Additional information may be obtained by writing to the Agricultural Engineering Department, Michigan State College.

PREVALENCE OF WILT DISEASES IN MAPLE AND ELM

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SECTION OF BOTANY

Elm and maple trees are affected by several diseases which are accompanied by wilting as one of the symptoms exhibited at some stage in the progress of the malady. There are a number of parasitic organisms capable of producing a diseased condition in elm with symptoms of wilting. Two of the most important elm pathogens native to this country are *Verticillium* sp. and *Dothiorella ulmicola* (formerly known as *Cephalosporium* sp.). Other species of fungi that have been found capable of causing elm trees to wilt and branches to die are *Sphaeropsis, Coniothyrium,* and *Vermicularia.*

The most serious pathogen which causes wilt in elm is the Dutch Elm Disease fungus, *Ceratostomella ulmi.* This fungus was introduced into the United States from Europe, and has produced a severe epidemic in

the vicinity of New York. Other lesser outbreaks have occurred, the nearest to this state being in Cleveland, Ohio, and Indianapolis, Ind.

Verticillium is the only known parasitic fungus causing wilt in maple. It has been proved to be the same fungus that infects elm as well as Japanese barberry and other ornamental shrubs.

Wilting and dying of the branches of elm and maple may also be brought about by non-parasitic causes. Deficient water supply due to drouth or root injury as well as the presence of illuminating gas in the soil, and suffocation of roots by packing of the soil produce these same symptoms.

Confusion between wilts of a parasitic and a non-parasitic nature may be avoided by examining a smooth cut made across the affected twig or branch. The presence of green (maple) or brown (elm) flecks and streaks in the wood indicates the presence of a parasitic fungus while the absence of discoloration indicates a non-parasitic trouble.

Because of the similarity of symptoms exhibited by the several fungi causing elm wilt, the exact diagnosis of this disease cannot be made in the field, but specimen pieces from affected branches must be collected and submitted to a plant pathological laboratory where a careful technical procedure is necessary to identify the pathogens.

The following observations on the prevalence of wilt diseases in maple and elm in Michigan are based on the specimens of wilting trees that have been submitted to the plant pathological laboratory of the Michigan State Agricultural Experiment Station for examination and diagnosis during the summer of 1938. A careful cultural and microscopic study was made of specimens from 51 cases of dying American elm located in various parts of the state. Specimens were submitted by city foresters, commercial shade tree men, and tree owners, and are believed to represent a fair cross section of the diseased elm in this state. Study of these specimens shows that 31% of the cases were infected with *Verticillium* wilt, 5% with *Dothiorella* wilt, 2% with *Coniothyrium* wilt, 2% with *Sphaeropsis* canker, and 0% with the Dutch Elm Disease. In 41% of the cases no fungus was found. When no fungus is found present, wilting may be assumed to be due to non-parasitic causes.

In a report from the Dutch Elm Disease Laboratory, Morristown, N. J., Dr. Curtis May states that to date no specimens infected with the Dutch elm disease have been received from Michigan.

A study of *Verticillium* wilt of maple was carried on during the last

Table 1. Prevalence of diseases in American elm.

	Number of cases	Per cent diseased
Verticillium wilt	16	31%
Dothiorella wilt	3	6
Coniothyrium wilt	1	2
Sphaeropsis canker	1	2
Dutch Elm Disease	0	0
Non-parasitic causes	30	60%
Total cases	51	

summer in Lansing as a representative city. Fifty-three cases of maple wilt were investigated. The relative prevalence of *Verticillium* wilt and wilts due to non-parasitic causes in hard and soft maples is recorded in the following table:

Table 2. Prevalence of Verticillium wilt in maple.

Variety	Number of cases Investigated	Number of cases of Verticillium wilt	Per cent of cases of Verticillium wilt	Number of cases of wilt non-parasitic	Per cent of cases of wilt non-parasitic
Norway Maple	42	18	42%	24	58%
Hard Maple	10	2	20	8	80
Silver Maple	1	0	0	1	100
Total	53	20	—	33	—

The greater susceptibility to infection by *Verticillium* of Norway maple, as compared with hard maple is shown by the foregoing figures. Of the actual *Verticillium* infections found, 90% were on Norway maple while only 10% were on hard maple.

Carl Fenner, assistant city forester of Lansing, estimates that there are 3,500 Norway maple trees (excluding recently set out trees) planted along streets and in parks of that city. On the basis of his estimates it is probable that 0.5% of the Norway maples are affected with *Verticillium* wilt.

While the actual number of elm and maple trees affected with wilt diseases is small, the interest of the general public in our shade trees is considerable and advice on the control measures applicable to these troubles is frequently requested. Such control measures as are known will be briefly outlined.

In the case of parasitic diseases, the prompt pruning of dead and dying branches is of first importance. If the wilt fungus is located in or has extended its growth into the main stem, the affected tree is likely to die in a few years. This is especially true when an elm tree is infected with *Dothiorella*. When elm and maple trees are found to be infected with the *Verticillium* fungus, prompt pruning of infected branches followed by fertilization with a commercial fertilizer to stimulate the growth of the tree often brings about an apparently complete recovery from this disease. The application of soil-soaking waterings during the hot dry months of summer is also very beneficial in aiding infected trees to recover. Whether trees which apparently recover will later show symptoms of disease again is not known.

Elm trees infected with the Dutch elm disease fungus must be removed promptly and the parts burned since this pathogen will kill any elm tree it infects and will spread readily to other elm trees, killing them.

In the case of non-parasitic troubles, soil-soaking waterings will overcome the effects of drouth, and aeration of packed soils by loosening of the soil or use of compressed air will alleviate the effects of suffocation. Fills over the roots of trees, especially maple, should be avoided. Presence of illuminating gas in the soil for any length of time usually results in the killing of trees. Prompt discovery and

mending of leaks in gas mains followed by aeration of the soil with compressed air machines to drive out the injurious accumulation of illuminating gas may prevent killing of trees by this agent. Injury to main roots of trees in construction work should be avoided if the tree is to be saved.

CHERRY TREE MORTALITY IN SIX MICHIGAN COUNTIES FROM 1930 TO 1938

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SECTION OF ECONOMICS

A study of cherry production in Michigan in respect to the number of bearing and non-bearing trees in the state was published by this station in 1933 (1).[1] It was followed in 1935 by one dealing with production and price trends in the pitted red cherry[2] industry (2). These two studies and the present paper are reflections of the importance of cherries in the horticulture of Michigan and of the continued interest among growers and processors in the status and trends of cherry production in the leading red cherry producing state in the country. A further reason for the present paper is that although at least three papers have been published in recent years on the length of life or tree mortality of apples in commercial orchards (3, 4, 5), no comparable study seems to have been made of red cherry tree mortality.

Scope and Method—In 1930 the 11 important cherry producing counties in Michigan[3] contained 87 per cent of the trees in the state, and the data in the present study were obtained in the two most important counties of each of the three producing areas.[4] These six counties included 80 per cent of the orchards and of the total number of trees in the 11 commercial counties in 1930. The data in the present study include red cherries only, since sweet cherries represented only 5 per cent of the state total in 1930. Since 95 per cent or more of the red cherry trees in Michigan are of the Montmorency variety (1), the data presented may be considered to be for that variety, although several blocks of the Early Richmond and English Morello varieties are included. The time included in the tree mortality data is the nine-year period from 1930 to 1938, inclusive.

The individual farm record sheets and township plat maps secured in 1930 were used as the basis of this project. The continued existence of each block of trees or the loss or abandonment of entire blocks was

[1]The figures in parentheses indicate references in the Literature Cited section at the close of the paper.
[2]The term red cherry is used in preference to sour cherry because the latter is regarded as a handicap by the industry.
[3]Southern area: Berrien, Van Buren, Allegan. Central area: Oceana, Mason, Manistee. Grand Traverse region: Benzie, Leelanau, Grand Traverse, Antrim, Charlevoix.
[4]Southern area: Berrien and Allegan. Central area: Oceana and Mason. Grand Traverse region: Leelanau and Grand Traverse.

checked for each farm reported to have had commercial plantings[1] of cherry trees in 1930. It was not feasible to obtain a record of trees lost in each block on each farm where no entire blocks had been lost or abandoned, but such records of scattered trees lost during the period were obtained from 20 growers located in the more intensively planted townships of each of the six counties. The term "block" in this study means all of the trees of the same age on one farm.

Mortality of Entire Blocks

The number of blocks, the acreage involved and the percentage of the total acreage of abandoned blocks of cherry trees in each of the six counties are included in Table 1, and the percentage attributed to each group of factors is also presented in Fig. 1. The number of trees originally present in these blocks which have disappeared since 1930 can be closely approximated by omitting the decimal points in the acreage columns; i. e., the five blocks of trees lost from winter injury in Berrien County contained about 367 trees.

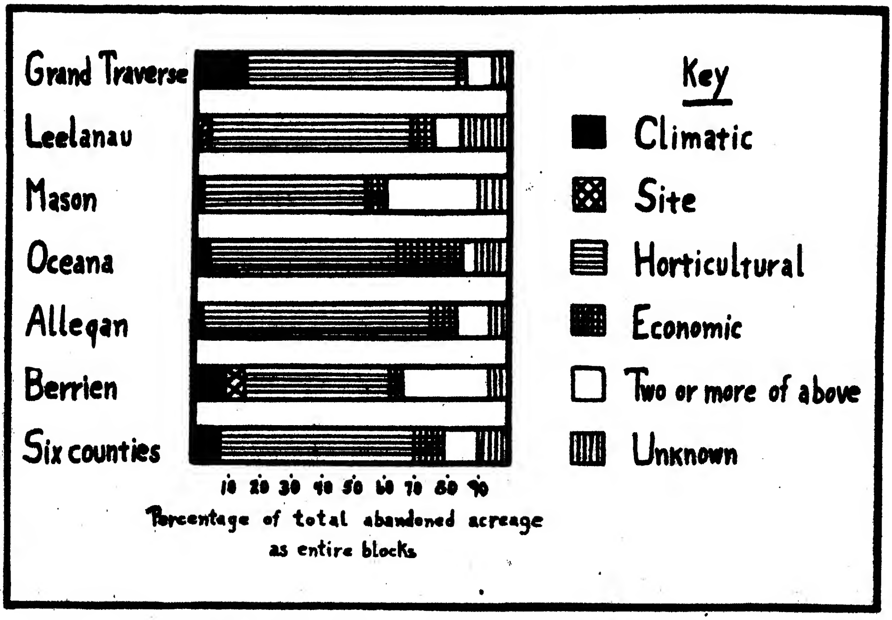

Fig. 1. Comparative importance of different groups of factors causing the abandonment of 250 blocks of cherry trees in six Michigan counties, 1930-38.

Climatic Factors—For the six counties as a whole the acreage lost from winter killing was more than twelve times as great as that removed because of frequent frost damage to blossoms or fruit. The two factors combined, however, accounted for less than 5 per cent of the acreage of abandoned blocks of trees. The importance of good air

[1]Orchards of 50 or more trees in Berrien and Allegan counties and of 200 or more trees in the others.

Table 1. Comparative importance of causes of abandonment of entire blocks of trees in six Michigan counties, 1930 to 1938.

Causes of Abandonment	Berrien			Allegan			Oceana			Mason			Leelanau			Grand Traverse			Totals		
	No. of Blocks	Acres	Per cent of Abandoned Acres	No. of Blocks	Acres	Per cent of Abandoned Acres	No. of Blocks	Acres	Per cent of Abandoned Acres	No. of Blocks	Acres	Per cent of Abandoned Acres	No. of Blocks	Acres	Per cent of Abandoned Acres	No. of Blocks	Acres	Per cent of Abandoned Acres	No. of Blocks	Acres	Per cent of Abandoned Acres
CLIMATIC FACTORS:																					
Winter injury.....	5	3.67	8.7	—	—	—	—	—	—	1	1.50	2.1	—	—	—	1	20.00	14.7	7	25.17	3.8
Frost injury......	—	—	—	—	—	—	1	2.00	1.0	—	—	—	—	—	—	—	—	—	1	2.00	.3
SITE FACTORS:																					
Unfavorable soil...	1	1.00	2.4	2	2.00	2.1	1	.50	.3	—	—	—	1	5.00	4.0	—	—	—	5	8.50	1.3
Unfavorable topography.....	1	1.50	3.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1.50	.2
HORTICULTURAL FACTORS:																					
Old age..........	6	5.00	11.8	11	13.30	14.1	6	12.00	6.3	4	8.35	12.0	2	10.00	8.0	11	49.50	36.3	40	98.15	14.9
Interplanted......	3	2.50	5.9	1	3.00	3.2	4	18.50	9.7	—	—	—	—	—	—	—	—	—	8	24.00	3.7
General neglect...	8	6.10	14.4	20	34.70	36.9	10	41.16	21.5	20	20.66	29.5	5	42.50	34.3	10	34.25	25.1	73	179.37	27.3
Inadequate spraying.......	5	5.50	13.0	3	9.25	9.8	11	24.75	12.9	2	5.25	7.5	—	—	—	3	8.00	5.9	24	52.75	8.0
Combination of these factors....	2	1.00	2.4	6	7.60	8.1	6	25.50	13.3	1	2.00	2.9	2	26.50	21.4	1	1.50	1.1	18	64.10	9.7
GROUP TOTAL	(24)	(20.10)	(47.5)	(41)	(67.85)	(72.0)	(37)	(121.91)	(63.7)	(27)	(36.26)	(51.9)	(9)	(79.00)	(63.7)	(25)	(93.25)	(68.4)	(163)	(418.37)	(63.6)
ECONOMIC FACTORS:																					
Low cherry prices.	1	1.00	2.4	1	2.00	2.1	—	—	—	—	—	—	—	—	—	—	—	—	2	3.00	.4
Farm abandoned..	—	—	—	2	6.00	6.4	8	35.75	18.7	3	3.75	5.4	1	9.00	7.3	1	2.00	1.5	15	56.50	8.6
Factors in two or more groups*.....	5	12.00	28.4	7	10.30	10.9	7	10.25	5.3	12	21.15	30.2	1	11.00	8.9	4	14.00	10.3	36	78.70	12.0
Unknown..........	3	3.00	7.1	2	6.00	6.4	4	21.00	11.0	5	7.30	10.4	2	20.00	16.1	4	7.00	5.1	20	64.30	9.8
GRAND TOTAL	40	42.27	100.0	55	94.15	100.0	58	191.41	100.0	48	69.96	100.0	14	124.00	100.0	35	136.25	100.0	250	658.04	100.0
Per cent of 1930 Acreage.........	......	2.68	......	......	9.21	......	......	4.95	......	......	10.36	......	......	3.60	......	......	2.84	......	......	4.28	......

*Also includes a few cases of poor nursery stock and of rabbit and mice injury.

drainage in reducing the risk of loss from winter killing is well illustrated by the seven cases included in Table 1. Of the seven blocks of trees one was on low lying flat land, three on plains with slopes of 3 per cent or less, two on broad ridges with slopes of 8 per cent or less rising from a broad plain, while only one was located on a site with predominant slopes of 15 per cent or more.

Site Factors—Unfavorable soil and topography were the least important single causes of the disappearance of entire blocks of trees. The explanation seems to be that while cherries generally thrive better on the lighter sandy or gravelly loam soils, they are relatively tolerant to other types, and their successful cultivation depends more upon satisfactory horticultural practices than upon the type of soil alone.

Horticultural Factors—Nearly two-thirds of the acreage in the abandoned blocks was lost because of horticultural factors. Old age and the removal of trees interplanted with apples may be regarded as "natural" causes in contrast with general neglect and inadequate spraying which depend upon the grower. The term "general neglect" is used here to indicate neglect in pruning, cultivation and fertilizer practices, as well as in spraying, while the latter classification is applied to blocks of trees otherwise satisfactorily handled. The reasons usually given for general neglect include absentee ownership, frequent changes of tenants, too few trees to justify spraying equipment, fruit production a very minor farm enterprise, the discouragement of low fruit prices in recent years as well as of farm prices in general, and—though apparent rather than expressed—the personality of the grower. The spraying may have been ineffective because of too few applications, incorrect timing, lack of thorough coverage of the trees, or various combinations of those causes. In most instances both general neglect and inadequate spraying resulted in severe damage from leaf spot which thus became the most important single immediate cause of the abandonment or removal of these 250 blocks of trees. When the losses of blocks of

Table 2. Ages at which 40 blocks of cherry trees died or were removed and the range in ages of 1,455 scattered trees lost from old age in 16 different blocks.

Abandoned Blocks*						Scattered Trees		
Exact Age When Lost	No. of Blocks	Age Range When Lost	No. of Blocks	Min. Age When Lost	No. of Blocks	Age Range When Lost	No. of Blocks Incl.	No. of Trees
17	1	17-25	1	Over 18	1	18-26	2	250
19	1	18-26	1	Over 20	1	20-28	1	10
23	1	20-26	1	Over 22	1	20-38	1	530
25	1	20-28	2	Over 25	3	21-29	1	100
27	2	23-31	1	Over 30	2	22-30	2	195
28	3	25-30	3			25-33	3	133
29	2	25-32	1			30-38	4	112
30	1	25-33	1			40-48	2	125
31	1	26-33	1					
33	1	30-36	2					
36	1	30-37	1					
38	1	30-38	1					
	16		16		8		16	1455

*Approximately 9,800 trees in these 40 blocks.

trees were attributed to the joint action of two or more of the horticultural factors, the more frequent combinations were old age and general neglect and old age and inadequate spraying.

As indicated in Table 1 there were 40 blocks of trees which had died or had been removed since 1930 because of old age alone. In 16 instances the trees had died or been removed in a single year, in 16 other cases the trees had died out over a known period of years, while in the remaining 8 blocks the growers were only able to state that the trees had disappeared since 1930. The ages of the trees in these three classes are shown in the left portion of Table 2.

The second part of Table 2 indicates the range in ages of scattered trees lost in 16 blocks owing to old age alone, to which later reference will be made. The 25- to 30-year age group includes 40 per cent of the blocks lost from old age alone. Although the disappearance of all blocks included in Table 2 were attributed by the growers to old age alone, it may easily be that those listed at less than 20 years of age were also due to other factors as well, especially soil type.

Economic Factors—Only two of the 250 blocks of trees were removed solely because of low cherry prices since 1930. The predominant economic factor was the abandonment of the entire farm, either because it was absorbed in the growth of an adjacent town or by a resort development, as in Allegan County, or was in a submarginal farming location in the other counties.

Combinations of Factors—An eighth of the acreage of abandoned blocks was lost as the joint result of factors in two or more of the previously mentioned groups. The number of blocks of trees abandoned or lost from various combinations of factors in two or more of the groups listed in Table 1 were as follows:

Winter injury and general neglect	13
Poor site and general neglect	11
Winter injury and inadequate spraying	4
Old age, poor site and general neglect	2
Winter injury, old age and general neglect	1
Winter injury and rodents	1
Winter injury and mechanical injuries	1
Poor site and old age	1
Poor site and inadequate spraying	1
Poor site, general neglect and drought	1
	36

Unknown—It was impossible to account for the disappearance of two per cent of the acreage in these blocks of trees, either because no one was at the farm when visited, the inability of neighbors to account for it, the fact that the present tenants or owners had come to the farm since the trees were removed, or for other reasons.

Variations Between Counties—Figure 1 illustrates the considerable variations between the six counties in the relative importance of each of the above mentioned groups of factors, while Table 1 indicates the variations between the combined effects of these factors. In Berrien County 2.68 per cent of the commercial acreage of red cherries in 1930 had disappeared through death or removal of entire blocks of trees, 2.84 for Grand Traverse, 3.60 for Leelanau, 4.95 for Oceana, 9.21 for

Allegan, and 10.36 for Mason Counties. The extent of the mortality in the latter two counties is sufficiently greater than in the others to suggest that they are marginal or nearly marginal cherry producing counties as a whole. Certain townships in each, however, are decidedly not marginal areas for cherries. Between 4 and 5 per cent of the red cherry trees of all ages present in the commercial orchards of these six counties in 1930 have since disappeared through the death or removal of entire blocks of trees. It should be mentioned that blocks of trees have been included in Table 1 and Fig. 1 when a few trees may still have been alive; but in such cases the remaining ones were either less than 5 per cent of the original number or were receiving no further care and were quite likely to be dead or removed in a year or two.

The Michigan Agricultural Experiment Station has published a number of bulletins designed to aid the cherry grower in reducing tree mortality, among which the following are still available in regard to specific topics; Michigan land type (6), selection of orchard sites (7), land types for fruit production (8), soil testing (9), management of sandy soils (10), soil erosion (11), maintaining cherry tree productivity (12), factors influencing cherry yields (13), pollination (14), spraying (15), and diagnosing orchard ills (16).

Mortality of Scattered Trees

Only part of the total tree mortality is represented by the trees lost through the disappearance of entire blocks. A larger part of the total consists of scattered trees throughout the still existing blocks which have been removed for various reasons. Such losses may or may not have been replanted, but the block as a whole continues in production. In order to obtain a sample of this form of tree mortality a record of the number of trees lost since 1930 was obtained from 20 growers in each of the six counties[1] who operated a total of 295 blocks of trees which had contained 126,747 trees in 1930.

The tree mortality data obtained from a total of 120 growers in six counties are summarized in Table 3.

It is significant to note that while the percentage of trees lost in this manner is rather uniform in the six counties with an average of 10 per cent, the proportion of those tree losses that were replaced varied from 6 per cent in Mason County to 52 per cent in Grand Traverse County, with an average of 32 per cent. The sample is either too small to establish the trend of tree mortality according to age or it may be impossible to determine it in this way since the joint effects of climatic, soil, and cultural factors may offset the tendency for older trees to have a higher mortality rate, the expected situation when factors other than age are the same. The scattered trees now missing in nearly all blocks had been lost over a period of years and the range in the ages of trees lost from old age alone was presented in Table 2. As in the case of entire blocks of trees removed because of old age, the mortality was largely among trees 25 years of age or older.

[1]Berrien: 34 blocks in Hagar, Bainbridge and Pipestone townships.
Allegan: 38 blocks in Ganges and Casco townships.
Oceana: 45 blocks in Hart and Shelby townships.
Mason: 42 blocks in Summit and Riverton townships.
Leelanau: 55 blocks in Leelanau, Sutton's Bay, Bingham, and Elmwood townships.
Grand Traverse: 81 blocks in Peninsular and Garfield townships.

Table 3. Summary of scattered tree mortality in 295 existing blocks operated by 20 growers in each of six Michigan Counties, 1930 to 1938.

Year Set	Age in 1930	Age in 1938	Berrien			Allegan			Oceana			Mason			Leelanau			Grand Traverse			Totals			Per Cent Lost	Per Cent of Loss Re-set
			Trees in 1930	Trees Lost	Trees Re-set	Trees in 1930	Trees Lost	Trees Re-set	Trees in 1930	Trees Lost	Trees Re-set	Trees in 1930	Trees Lost	Trees Re-set	Trees in 1930	Trees Lost	Trees Re-set	Trees in 1930	Trees Lost	Trees Re-set	Trees in 1930	Trees Lost	Trees Re-set		
1900	30	38	—	—	—	—	—	—	115	70	—	625	112	100	—	—	—	—	—	—	740	182	100	24.6	54.9
1901	29	37	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1902	28	36	—	—	—	—	—	—	50	10	—	—	—	—	—	—	—	—	—	—	50	10	—	20.0	—
1903	27	35	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1904	26	34	—	—	—	—	—	—	—	—	—	175	20	5	—	—	—	—	—	—	175	20	5	11.4	25.0
1905	25	33	10	—	—	185	93	15	700	50	25	—	—	—	—	—	—	—	—	—	895	143	40	16.0	28.0
1906	24	32	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6	—	—	—	—
1907	23	31	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	215	—	—	215	—	—	—	—
1908	22	30	100	70	—	—	—	—	—	—	—	—	—	—	—	—	—	1000	325	—	1100	395	—	35.9	—
1909	21	29	—	—	—	—	—	—	290	235	—	—	—	—	—	—	—	750	450	300	1040	685	300	65.9	43.8
1910	20	28	95	23	20	—	—	—	2000	220	70	290	10	—	2750	100	—	1100	310	225	6235	663	315	10.6	47.5
1911	19	27	—	—	—	—	—	—	—	—	—	200	10	—	3300	500	—	960	200	—	4460	710	—	15.9	—
1912	18	26	475	37	—	25	12	—	200	22	—	112	5	—	—	12	—	977	350	125	1789	438	125	24.5	28.5
1913	17	25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	300	1	1	300	1	1	.3	100.0
1914	16	24	—	—	—	—	—	—	—	—	—	150	5	—	—	—	—	—	—	—	150	5	—	.3	—
1915	15	23	—	—	—	190	15	—	600	60	30	245	10	—	—	—	—	—	—	—	1035	85	30	8.2	35.3
1916	14	22	—	—	—	—	—	—	—	—	—	—	—	—	400	250	—	845	100	100	1245	350	100	28.1	28.6
1917	13	21	—	—	—	—	—	—	—	—	—	—	—	—	1100	450	—	—	—	—	1100	450	—	40.9	—
1918	12	20	162	14	8	200	20	—	—	—	—	550	60	—	4300	360	35	1622	147	145	6834	601	188	8.8	31.3
1919	11	19	50	5	—	395	30	28	280	5	5	—	—	—	2000	50	30	—	—	—	2725	90	63	3.3	70.0
1920	10	18	—	—	—	1200	75	35	1650	150	150	250	10	—	2900	350	—	800	160	50	6800	745	235	11.0	31.5
1921	9	17	634	60	—	830	37	10	—	—	—	—	—	—	1700	250	40	390	5	5	3554	352	55	9.9	15.6
1922	8	16	186	36	—	484	55	50	600	30	5	—	—	—	6350	995	35	2118	604	102	9738	1720	192	17.7	11.2
1923	7	15	—	—	—	220	10	10	300	5	5	650	15	—	5299	135	95	3165	215	215	9634	380	325	3.9	85.5
1924	6	14	—	—	—	180	25	15	2616	80	50	475	8	5	4835	375	10	1618	83	40	9724	571	120	5.9	21.0
1925	5	13	419	24	8	580	27	—	2350	65	—	1140	30	—	2675	77	12	450	10	—	7614	233	20	3.1	8.6
1926	4	12	20	—	—	81	8	—	7258	484	296	1375	282	250	2695	55	15	2298	134	132	13727	963	693	7.0	72.0
1927	3	11	289	39	—	797	32	21	2596	280	255	1430	172	105	1200	26	11	5854	146	122	12166	695	514	5.7	74.0
1928	2	10	302	67	—	440	22	6	560	20	10	—	—	—	9925	1115	280	2810	92	75	14037	1316	371	9.4	28.2
1929	1	9	120	6	6	672	42	17	550	6	6	655	75	—	920	95	10	3097	117	95	6014	341	134	5.7	39.3
1930	0	8	150	3	—	295	15	—	—	—	—	—	—	—	1850	145	—	1320	109	102	3615	272	102	7.5	37.5
Totals			3018	384	42	6774	518	207	22715	1792	907	8322	824	465	54199	5340	573	31689	3558	1834	126717	12416	4028	9.8	32.4
Per Cent Lost			13	—	—	8	—	—	8	—	—	10	—	—	10	—	—	11	—	—	10	—	—	—	—
Per Cent of Loss Reset			11	—	—	40	—	—	51	—	—	6	—	—	11	—	—	52	—	—	32	—	—	—	—

Table 4. Comparative importance of causes of the scattered tree mortality in 295 existing blocks operated by 20 growers in each of six Michigan counties, 1930 to 1938.

Causes	Number of Trees Lost						
	Berrien	Allegan	Oceana	Mason	Leelanau	Grand Traverse	Six Counties
Winter injury	—	—	117	5	50	217	389
Unfavorable soil	95	20	85	—	—	620	820
Old age	70	73	130	147	100	935	1,455
Inadequate spraying	22	—	295	375	1,200	—	1,892
Combinations and Misc.*	197	425	1,165	297	3,990	1,786	7,860
Total	384	518	1,792	824	5,340	3,558	12,416

Causes	Percentages						
	Berrien	Allegan	Oceana	Mason	Leelanau	Grand Traverse	Six Counties
Winter injury	—	—	6	*	1	6	3
Unfavorable soil	25	4	5	—	—	17	7
Old Age	18	14	7	18	2	26	12
Inadequate spraying	6	—	16	46	22	—	15
Combinations and Misc.*	51	82	66	36	75	51	63
Total	100	100	100	100	100	100	100

*Miscellaneous includes: Wind, snow and ice, drouth, frosty location, erosion, excess fertilizer too close to roots, poor nursery stock, replacement of Early Richmond variety, blackheart, mushroom root "pin hole" borers, rodents, and mechanical injuries during cultivation and harvesting.

The number and proportion of tree losses attributed to the various causes is presented in Table 4.

Except in Mason County the largest proportion of the scattered tree mortality was the result of several factors. This part of the mortality in Table 4 includes trees lost by the combined effect of two or more causes and those lost by single factors, some being lost through winter injury, some by unfavorable soil, some by inadequate spraying or by a miscellaneous cause. In such instances the growers were frequently unable to recall the number of trees lost from each cause separately, necessitating the final classification used in Table 4.

Total Tree Mortality

Data obtained in these six counties (an 80 per cent sample of the commercial cherry orchards in the 11 important cherry counties of Michigan) show that approximately 15 per cent of the red cherry trees in these orchards in 1930 have been lost since then, 5 per cent by the death or removal of entire blocks and 10 per cent through the loss of scattered trees in blocks that are still in production. Since nearly a third of the loss of scattered trees was replaced, the net mortality in blocks existing in 1930 in the six counties amounts to 12 per cent. The figure of 10 per cent mortality for scattered trees is conservative, because the records were obtained in the more intensively planted town-

ships and the orchards in general were noticeably better managed on the whole than those in the townships with only a comparatively few cherry orchards. Although based entirely on general impressions gained while making the study, it seemed to the writer that the mortality of scattered trees in the latter townships was at least a third greater than in the townships with many cherry plantings. Should later studies of mortality in these more marginal areas bear out that impression, it would mean that during the period in question a given number of cherry trees has decreased at not to exceed 4 per cent per year. On account of the rapid expansion of the cherry industry in Michigan between 1920 and 1930 and a much slower growth since 1930, the average age of trees in 1938 is undoubtedly somewhat greater than several years ago. As the number of trees become more stabilized a somewhat greater annual mortality may be expected. Nevertheless, this study shows that under average climatic and soil conditions and with average care the sour cherry orchard is a long-lived enterprise. Furthermore, tree mortality could be substantially reduced by better care, particularly better spraying to reduce leaf spot attack and the winter injury that often follows in its wake.

Literature Cited

(1) Motts, G. N., Scholl, C. A., and Chapin, J. W. "Trends in Cherry Production in Michigan." Mich. Agr. Exp. Sta. Spec. Bul. 237. 1933.

(2) Marshall, R. E. "Production and Price Trends in the Pitted Red Cherry Industry." Mich. Agr. Exp. Sta. Spec. Bul. 258. 1935.

(3) Marshall, R. E. "Length of Life of Apple Trees Based on Observations in Virginia and Michigan." Proc. Amer. Soc. Hort. Sci. 1921.

(4) Crane, H. L. "Observations on the Factors Influencing the Length of Life of Apple Trees in West Virginia." Proc. Amer. Soc. Hort. Sci. 1921.

(5) Brierley, W. G. "Notes on the Length of Life of Apple Trees in Minnesota." Proc. Amer. Soc. Hort. Sci. 1921.

(6) Veatch, J. O. "Agricultural Land Classification and Land Types of Michigan." Mich. Agr. Exp. Sta. Spec. Bul. 231. 1933.

(7) Partridge, N. L. and Veatch, J. O. "Selection of Orchard Sites in Southern Michigan." Mich. Agr. Exp. Sta. Circ. Bul. 155. 1936.

(8) Veatch, J. O. and Partridge, N. L. "Utilization of Land Types for Fruit Production, Berrien County, Michigan." Mich. Agr. Exp. Sta. Spec. Bul. 257. 1934.

(9) Spurway, C. H. "Soil Testing." Mich. Agr. Exp. Sta. Tech. Bul. 132. (2nd Rev.). 1938.

(10) Grantham, G. M. and Millar, C. E. "Sandy Soils—Methods of Management." Mich. Agr. Exp. Sta. Spec. Bul. 248. 1934.

(11) Partridge, N. L. "Soil Erosion in Michigan Orchards." Mich. Agr. Exp. Sta. Circ. Bul. 162. 1937.

(12) Gardner, V. R. "Maintaining the Productivity of Cherry Trees." Mich. Agr. Exp. Sta. Spec. Bul. 195. 1930.

(13) Gardner, V. R. "Factors Influencing the Yields of Montmorency Cherry Orchards in Michigan." Mich. Agr. Exp. Sta. Spec. Bul. 275. 1936.

(14) Marshall, R. E., et al. "Pollination of Orchard Fruits in Michigan." Mich. Agr. Exp. Sta. Spec. Bul. 188. 1929.

(15) Rasmussen, E. J., Hutson, Ray, and Cation, Ronald. "Spraying Calendar." Mich. Agr. Exp. Sta. Ext. Bul. 154 (Rev.). 1938.

(16) Gardner, V. R., et al. "Diagnosing Orchard Ills." Mich. Agr. Exp. Sta. Spec. Bul. 164. 1927.

RELATION OF HIGH OCTOBER TEMPERATURES TO RATE OF RIPENING OF APPLES HELD IN AIR-COOLED STORAGES

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One cannot predict the temperatures that will be recorded between the time this paper is being written (October 19) and the date it will reach its readers. Regardless of weather trends subsequent to the time of this writing, however, the record-breaking temperatures that prevailed between October 10 and October 19 will make this season one of the most unfavorable for the operation of air-cooled storages that the apple industry of this region has experienced in the 15 years that the writer has been associated with the study of these storages. It therefore appears advisable to warn owners of air-cooled storages that apples held in common or air-cooled storages may be expected to ripen considerably in advance of the normal dates and must be merchandised earlier if they are to reach the consumer in prime condition.

Practically all apples that are being held in common storage this season were harvested between September 15 and October 15. The mean daily outdoor temperature at East Lansing for the latter half of September averaged about three degrees below the normal daily means. The daily maxima, however, were slightly higher than the normal daily maximum temperatures, so it would appear that most operators of air-cooled storages should have attained what might be termed a normal storage room temperature by October 1, or fruit temperature reading of 48° to 50° F.

During the first nine days of October there were only three days at East Lansing when the mean temperatures were above the normal. A minimum temperature of 28° was recorded on the morning of October 7. The mean daily temperatures for this period averaged approximately two and one-half degrees below the normal, though again, the daily maximum temperatures were higher than normal. On the whole, it would appear that air-cooled storages should have afforded approximately normal seasonal temperatures up to October 9.

The mean daily temperatures during the next 10 days (October 10 to 19, inclusive) exceeded the normal means by 6 to 19° and a maximum of 85° was recorded on October 16. The average mean daily temperatures during this period exceeded the normal by approximately 13°.

Earlier investigations of this experiment station have shown that the average fruit temperature in a properly managed air-cooled storage should be about four degrees lower than the average daily mean temperatures. In other words, if these storage rooms were being loaded between October 10 and 19 and were managed in the usual manner, one would expect a fruit temperature of approximately 60° on October 19. If the loading had been completed by October 10 and the storage had been tightly closed throughout the period of excessively high temperatures, the temperature of the apples might be less than 50°. Observations made October 14 and 15 showed temperatures ranging from about 45° in one storage where the loading was completed early to as high as 58° where much loading was done during the week of October 10.

It is well known that the rate of ripening at 50° is two times the rate at 40°, and that apples ripen twice as rapidly at 65° as at 50°. It is then apparent that apples held in air-cooled storages were ripening approximately twice as rapidly during the second 10 days of October 1938, as in normal years. Ten days under such conditions would result in as much ripening as would occur in three weeks in a normal season, even if it were possible to reduce immediately the temperature of the apples on October 20 to approximately 44°. This is impossible in a storage where the operator is depending on natural or fan-driven air-flow through the storage room for cooling.

The most optimistic guess of the writer, based on theoretical considerations, is that most operators of air-cooled storages should plan to merchandise each variety at least one month earlier than has been the practice in what might be termed normal years. A few growers who managed to keep well-insulated storages closed during the very hot weather may find that these apples will keep nearly as well as they have kept in the average year.

Calendar dates cannot be relied upon entirely in determining when the fruits should be marketed. The ground color changes should be watched carefully and the rate of softening may be of some value as an index of degree of ripeness. Perhaps the best criterion as to the time of marketing is based upon the condition of fruits after removal from the storage room to the kitchen or living room for a week, for this is essentially the treatment most of the apples will be subjected to before consumption. When fruits tend to become mealy or show a loss of quality due to over-ripeness when held for a week at living room temperatures, they should be moved immediately, for it is claimed by many experienced men that attempts to force over-ripe apples having poor quality on the consumer is diverting consumer choice from apples to citrus fruits.

THE RUBBER TIRED FARM WAGON

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Application and Use

The application of pneumatic tires to tractors and more recently, to a number of field machines has demonstrated beyond doubt a greater efficiency as related to rolling resistance than is possible with the conventional steel wheel. As a result, many farmers have converted their farm wagons or have built wagons of automobile and truck parts to place them on pneumatic tires. Many inquires have been received by Michigan State College for plans to assist farmers in making these conversions. This article was therefore designed to make available such plans as we believe were worthy of reproduction.

Several farms in the vicinity of the College were visited to locate if possible, types of farm wagons that could be recommended. Unfortunately, these wagons were not entirely satisfactory and for the most part were in the process of rebuilding. The plans shown are adaptations of automotive parts to farm wagon construction made by Jack Mac Allan, the College blacksmith, who has done much work on this problem.

Use of Photographs

Photographs* are used in the preparation of this article because it is believed that they are more understandable than the conventional type of plans. The photographic cuts include complete assembly views of three wagons. Figures 1 to 5, inclusive, represent a conventional farm wagon converted on rubber tires. Figures 9 to 16, inclusive, represent a wagon built up of two front axles of an automobile and a special chassis construction. Figures 6 to 8, inclusive, represent a modification of the second wagon, as can be readily identified.

Description of Wagons

The Conventional Farm Wagon Converted on Rubber Tires

This construction as indicated by figures 1 to 5, inclusive, represents the simplest change known. The wagon shown in Fig. 1, is essentially the same as the conventional farm wagon, except that axle skeins have been removed, and the axles have been cut away to fit the contour of the two Chevrolet's front axles as shown at 4A and 5A representing axle attachments.

The steel axles are attached to the wooden axles by means of U-bolts. Note U-bolts in figures 3B and 4B for front and rear axles respectively. For front axle, the U-bolts pass over sand board through the fore-

*Photographs were prepared by Floyd Linebaugh of the Agricultural Engineering Department.

hound, along side of the wooden axle and fasten at the spring supports of the steel axle. The fastening of the steel axle is similar at the rear end except that U-bolts pass between the rear bolster and the false bolster as shown in Figure 4B. Note the location of brace irons as found in the following figures: 1C, 2C, 4C, and 5C. The braces are made of ½" x 1½" flat stock.

The wheel spindle is fastened firmly to the axle by means of two pieces of angle iron, one of which is shown in detail in figures 5D and at 16A. The spacing of the drilled holes can be readily determined. All four wheel spindles are attached in this manner to the axle because they must be rigid. There will be a slight camber or tilting of the wheels from the vertical, but this condition is not objectionable.

A suggested order of procedure follows:

(1) Obtain two front axles with spindles and wheels from a 1928 Chevrolet car chassis.
(2) Dismantle the farm wagon to have access to the wooden axles for cutting and trimming.
(3) Remove skeins from axle.
(4) Cut and trim wooden axle to fit the contour of the steel axle.
(5) With the wheels assembled to the Chevrolet axle, adjust so that wheels are parallel or in line, and in this position spot weld the spindle to the axle, to maintain proper alignment.
(6) Obtain enough 1½" angle iron to make eight pieces to serve as clamps for the axle spindle.
(7) Cut angle iron to proper length, drill to match holes and assemble to form a rigid lock of spindle to axle.
(8) Forge four U-bolts for front and rear axles and assemble parts.
(9) Measure length of braces needed, drill and assemble as indicated in figures 1 to 5 inclusive.
(10) Reassemble the wagon.

A Built-up Wagon Using Car Front Axles, and Fabricated Chassis Construction

This construction deals essentially with two 1928 Chevrolet front axles inverted as shown in figure 9 at A. The front axle in the wagon assembly is turned over to bring the steering arm tie rod in front so that fastening to tongue is made possible. The front bolster is made from a steel eye beam of three-inch depth. The front bolster stakes are likewise eye beam construction, set into the webs of the bolster eye beam and welded to a plate attached to axle as shown in Fig. 13A. Figure 13 at B represents a false bolster not shown in the assembly. The rear bolster stakes are made from ½" x 1" flat stock welded to axle as shown in 9B and 10B. The wagon reach is made of two-inch iron pipe and extends from front axle to a short distance back of the rear axle as indicated in Fig. 9C.

The reach is free to slide into the journal as shown in figures 9D and 14D. This journal is made of a piece of 2½" pipe welded to axle by means of a clamp.

The sleeve as shown in figures 9E and 11A is made of 2½" pipe and likewise is free to turn and slide on the reach proper. The wagon wheel base is regulated and clamped into position by the two collars as shown

in Fig. 11 at B. The braces to rear axle are welded to sleeve 11A as shown in Fig. 11 at D and at the other end the braces are bolted to axle at the spring support flanges as shown in Fig. 10 at C.

The rear wheel spindles are clamped to axle in exactly the same manner as with the first wagon.

The front wheels are attached through the spindle arms to the tie rod in the conventional manner used on automobiles as shown in Fig. 9.

It will be necessary to bend the spindle steering arms toward the wheels in order that the wheels will have proper angles for turning. The tie rod must be lengthened to accommodate this change.

The braces from reach to front axle are shown in figures 12 and 15. Figures 12, 14, and 15 represent views taken from underneath the chassis in order to show method of attachment.

Hitch

The hitch for this wagon is shown in figures 8, 9, and 15. Figure 15, previously mentioned, is photographed from underneath and should not be confused with the other two views. Figure 8 shows the hitch in close-up.

The pivot point of hitch is shown just in front of axle at point (A) through U-iron (B) which is welded to the axle. This U-iron extends back of the front axle, and provides an attachment for the reach which is shown at (A) in Fig. 7. Over and below the U-iron are two plates which are welded to the hitch proper at point C not clearly shown because of position of tie rod, (D). These plates serve as a pivot point as shown at (A) in Fig. 8.

The tongue is attached to the hitch as shown at (E) in Fig. 8.

The U-bar (F) supporting the tongue is reinforced by a U-bar G. Bolt (H) is welded to U-Bar, and provides an attachment for the rod through the slotted block (I). This slotted block is welded to tie rod and provides free motioń of tie rod in accomplishing steering. The front U-bar (J) is used as a guide for the tongue, which enables backing up when used with horses, providing a stop and preventing jackknifing.

A Modification of Wagon No. 2

This wagon differs from the wagon just described in the axle construction as shown in figures 6, 7, and 8. It will be recognized that the axles are set in the normal position rather than inverted and uses eye-beam bolster construction. This construction is clearly shown in Fig. 7 which is a rear view of the front axle.

The rear axle bolster construction is identically the same as the front axle as shown in Fig. 6. The hitch and reach construction have been covered in the description of the second wagon.

Conclusion

It is expected that many new ideas will bring about improvements in the plans suggested. The wagons described in this article have been built and used on the College farm, and may be reproduced with confidence in the outcome. Suggestions on other combinations and simple devices are welcomed.

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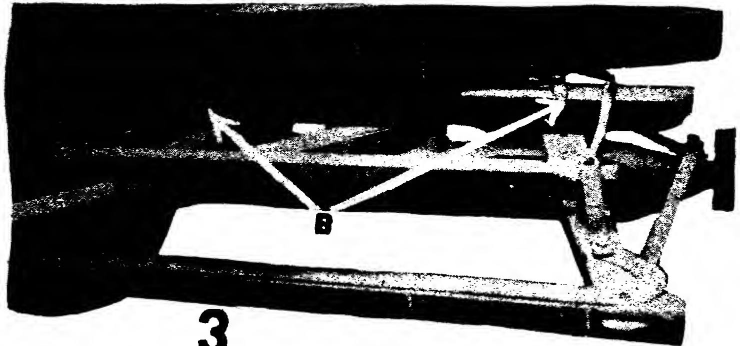

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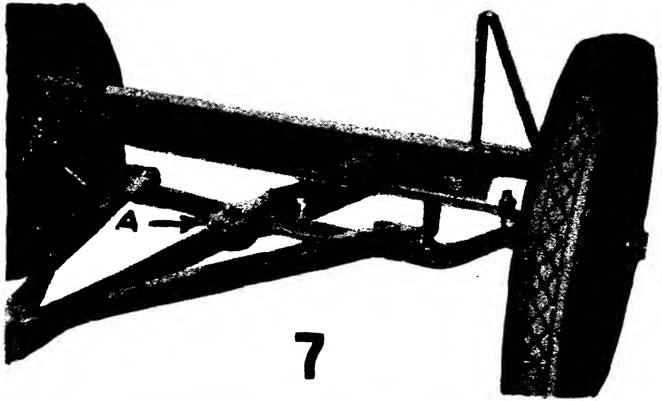

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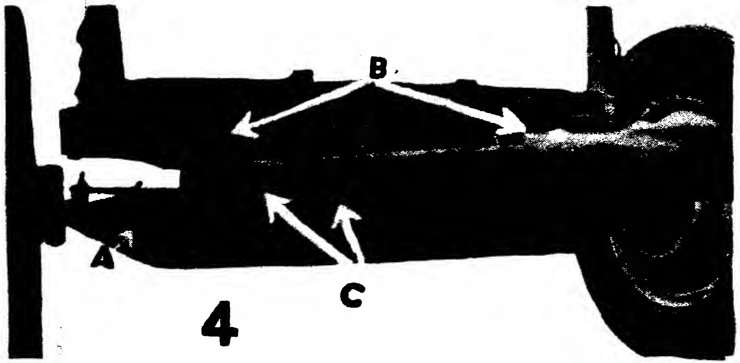

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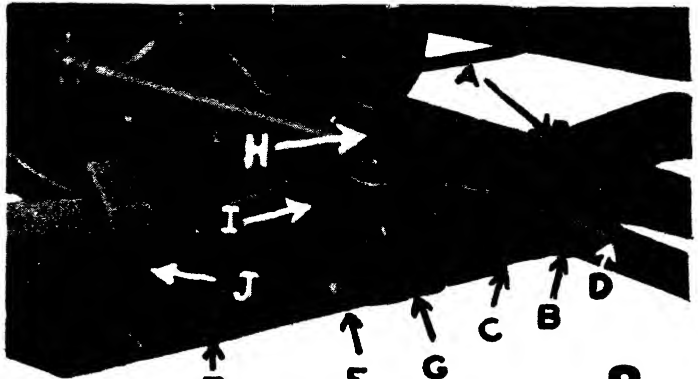

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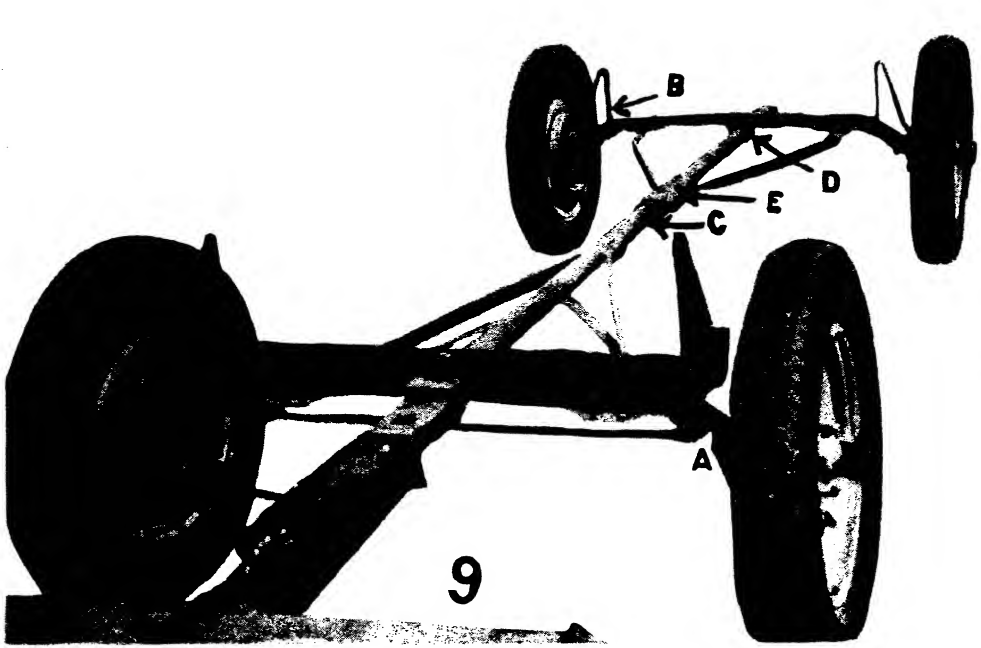
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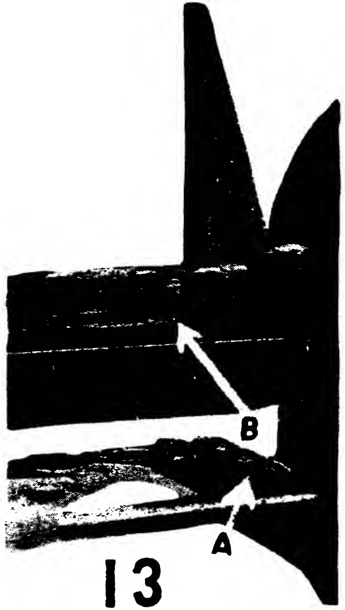
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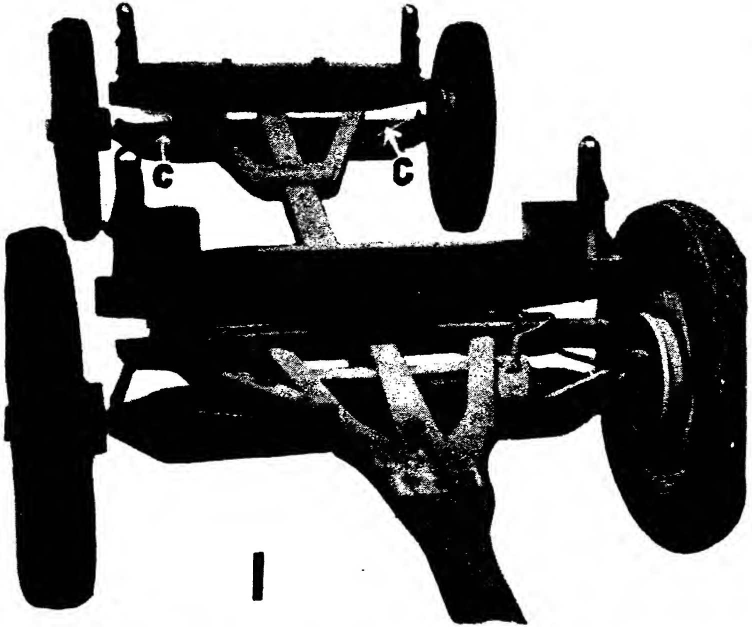
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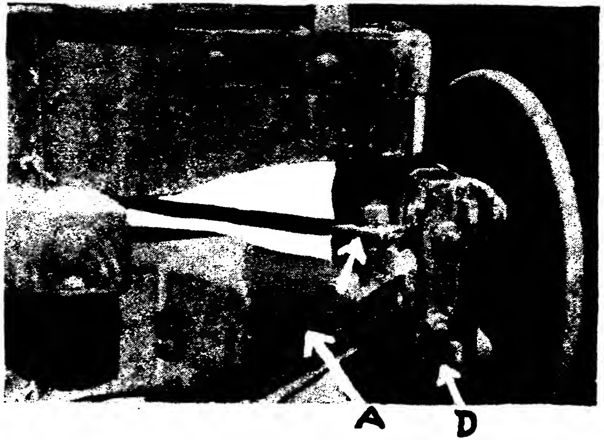
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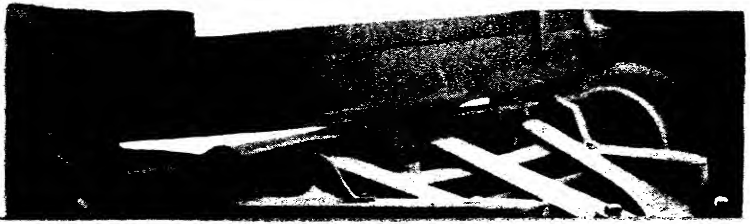

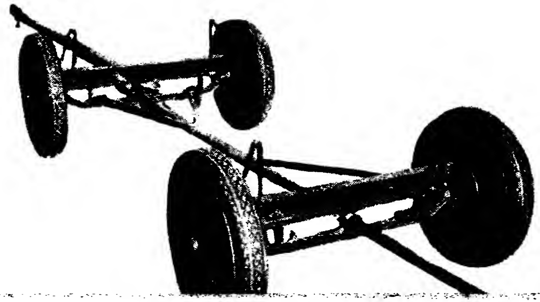

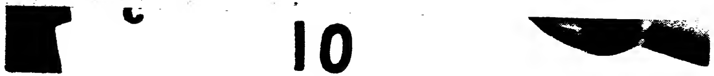

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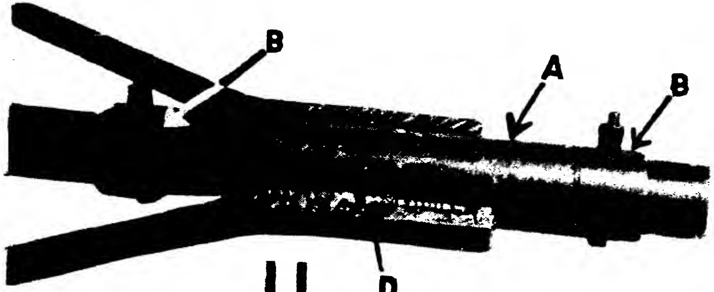

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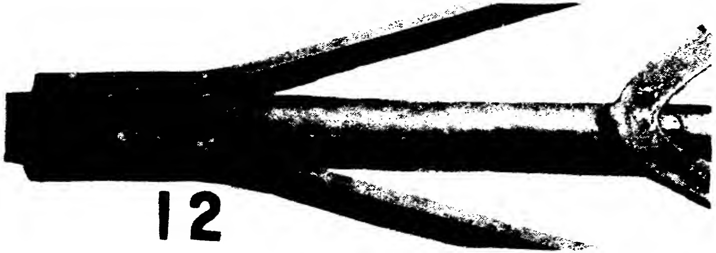

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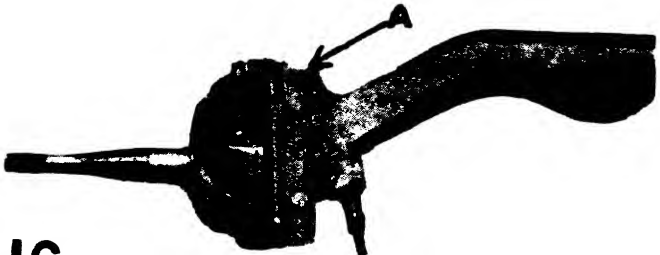

16

THE POTASH SITUATION IN MICHIGAN ORCHARD SOILS

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Potash is essential for the normal growth and development of plants, and fruit trees are no exception to this general rule. They require potash to manufacture the carbohydrates, proteins and fats which are necessary to produce the new tissues in the roots, shoots, leaves, and fruits. Without potash, nitrogen in the soil and that applied to the tree in the various forms of nitrogenous fertilizers is not fully utilized by the tree. A lack of potash might therefore be expected to reduce length and diameter growth. Soils contain potash in different amounts, according to their origin and previous treatment, and vary considerably in their power to release the potash that they do contain. Plants themselves vary in their power to absorb this potash from the soil and in their reaction to it. Although fruit trees will grow in soils which vary considerably in composition, their performance is necessarily closely associated with the nature and composition of the soil in which they are growing. Though potash is only one of a number of the materials which plants take in from the soil, its presence in adequate amounts is necessary for maximum fertility and crop production.

In order to study the relationship between fruit tree performance and available potash supply in the soil, various projects were set up during the period from 1934 to 1937. These projects consisted of (1) fertilizer treatments in a number of commercial orchards throughout the fruit growing areas of Michigan, covering a representative range of soils and varieties, (2) pot experiments at East Lansing, where soil and moisture conditions were controlled, and (3) a survey of orchards made in the fall of 1937 to determine whether potash is a limiting factor in fruit tree growth and production.

Field Experiments

The field experimental plots were laid out in 1934 in conjunction with comparisons of Cyanamid, sulphate of ammonia, and superphosphate fertilizers. Observations were made on tree performance during the 1935, 1936 and 1937 seasons, after which the project was terminated.

Apple, cherry and peach orchards were selected to represent the typical soil types and climatic regions associated with commercial fruit growing in Michigan. In the southwest section of the State, in Berrien, Van Buren, and Allegan counties, there were four peach, one apple and three cherry orchards under observation. These were growing on sandy to sandy loam soils. In Mason and Oceana counties, situated on the west coast of the state, about the middle of the lower peninsula, were three cherry and one apple orchard in the project. These orchards were all growing on sandy soils. Towards the north end of

the lower peninsula, in Grand Traverse county, there were three cherry orchards, all growing on a sandy to sandy loam soil. Thus there were a total of two apple, four peach, and nine cherry orchards under observation.

The basic plan for applying the various fertilizers may best be shown diagramatically in Fig. 1.

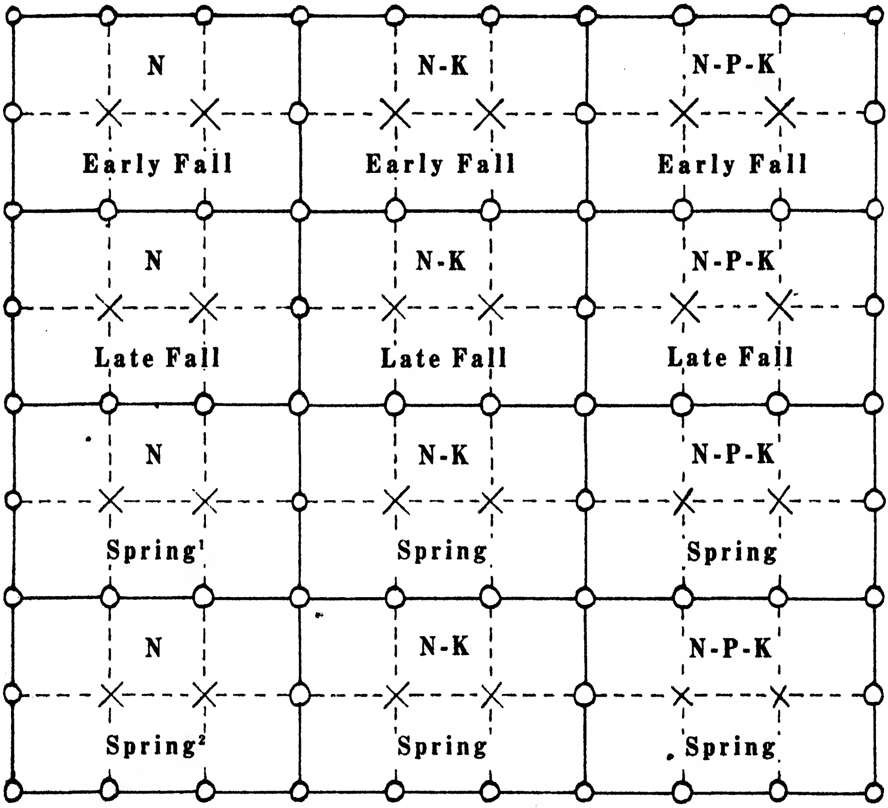

Fig. 1. Basic plan for fertilizer applications.
[1]Sulphate of ammonia as the nitrogenous fertilizer.
[2]Cyanamid as the nitrogenous fertilizer.

The solid lines show the extent of each plot. The crosses indicate the treated trees and the circles indicate the buffer trees between each treatment. A deviation from the usual practice of applying fertilizer in a ring consisted in applying it in squares adjacent to the treated tree. The dotted lines indicate the extent of these squares. Thus, in each treatment, consisting of two trees, there would be six separate applications corresponding to the six adjacent squares. This method eliminated any possibility of a double application where two rings might overlap and ensured an even distribution of the fertilizer. According to this method any fertilizer which might not be utilized by the tree

roots would be taken up by the cover crop roots, thus helping to build up the organic matter of the soil and indirectly benefit the tree. The various fertilizer applications were made at different times of the year for comparative purposes. The basic rates of application were as follows: nitrogen, 250 pounds per acre of either Cyanamid or sulphate of ammonia; potash, 100 or 200 pounds per acre of muriate of potash, depending on the nature and age of trees; superphosphate, 150 or 300 pounds per acre, also depending on the nature and age of trees. The early fall applications were made around the middle of September, the late fall applications a month later, and the spring applications towards the end of March or early April for Cyanamid, and about two weeks later for sulphate of ammonia.

In order to study the changes in potash content of the soil, soil samples were tested for available potash at the beginning of the experiment in 1934, and at monthly intervals throughout the growing seasons of 1936 and 1937. The orchards from which these soil samples were taken were chosen so as to give as wide a range of soil and fruit tree variety as possible and still keep the number low enough for practical consideration. The trees in these orchards were comparatively uniform from the standpoint of vigor and thrift. The results from these tests show that, though there was a slight increase in amount of available potash in both treated and untreated plots, this increase was insignificant, plots testing 0-10 pounds per acre available potash at the beginning of the experiment and 0-20 pounds per acre at the end of the project. This lack of measurable increase in the available potash content of the soil following potash application is probably due to the high fixing power of these soils.

The effect of potash on the condition and vigor of the trees was studied by making monthly observations on the general color and health of the foliage. Since it has been suggested by some investigators that potash may prevent some of the burning which often occurs when Cyanamid is applied late in the spring, special care was taken to observe any reduction of injury following the use of potash with Cyanamid. There was a certain amount of foliage injury in 1936 due to late spring Cyanamid applications, but the addition of potash to those plots receiving Cyanamid did not prevent or alleviate this burning of the foliage, except in one case. What appeared to be a slight benefit from the use of potash in this one case may have been due to the better condition of the trees at the beginning of the experiment rather than the result of any potash application. Trees receiving potash were not any more vigorous and did not carry any greener or healthier foliage than did trees not receiving this fertilizer.

From the results obtained over this three-year period, it can be stated that potash under the conditions of these investigations has not been beneficial to apple, cherry or peach trees in any way that could be observed, though the possibility of a long time effect which may develop following the continued use of this fertilizer is recognized.

Pot Experiments at East Lansing

In order to study the effect of potash on fruit trees grown under controlled soil and moisture conditions, two separate experiments were conducted. As in the field experiments, these pot experiments

were run in conjunction with Cyanamid trials. The first of these two-pot experiments consisted of one-year-old Montmorency cherry trees grown in three different soil types in wooden tubs. The trees were grown for a year in the tubs and then given the various fertilizer treatments in 1936 and 1937. Although kept outdoors, the soil in which these trees were grown was covered so as to maintain it at a definite moisture content. The second of these pot experiments was conducted on one-year-old Montmorency cherry trees, all grown in sandy soil contained in galvanized iron cans. They were planted in the early part of January 1937, after having been subjected to cold weather in order to break the rest period, and then grown in the greenhouse during the period of the experiment.

For convenience, the first of these pot experiments will be called the Tub Experiment and the second the Greenhouse Experiment.

Tub Experiment

There were 150 trees in this experiment, each grown in a separate tub. Fifty of these trees were grown in a sandy soil, 50 in a sandy loam soil, and 50 in a loam soil. In 1936, each group of 50 trees was divided so that half of these were grown in a soil maintained at a low moisture content, and half in a soil maintained at a high moisture content. The actual percentages varied according to the type of soil. For sand these were 4.2 and 14.8, for sandy loam 6.3 and 17.0, and for loam 10.4 and 25.6%. In each group of 25 trees, the following treatments were given:

1. Cyanamid at rate of 700 lbs. per acre plus potash at rate of 200 lbs./A..	5 trees
2. Cyanamid at rate of 300 lbs. per acre plus potash at rate of 200 lbs./A..	5 trees
3. Cyanamid at rate of 700 lbs. per acre	5 trees
4. Cyanamid at rate of 300 lbs. per acre	5 trees
5. Check—no fertilizer	5 trees
	25

In 1937, the treatments were somewhat modified in order to compare nitrate of soda and sulphate of ammonia with Cyanamid, each with and without potash. The variations in high and low moisture were discontinued so as to permit this treatment to be carried out. It was thought that more valuable information could be obtained on the potash-nitrogen relationship by making such a change than by continuing the project as originally outlined.

Results

1936—The effect of the various treatments was determined in several different ways. Total twig growth was measured at the end of the growing season. Notes on foliage conditions were made during the year. When it was seen that certain treatments were causing injury, the extent of such injury was determined by making leaf counts on all trees and by measuring the secondary growth stimulated by this defoliation.

Considering total twig growth in the different soil types, the greatest growth in sand and sandy loam soil was obtained with Cyanamid at the rate of 300 pounds per acre at a high moisture content. When potash was added to the high rate Cyanamid application in high and

low moisture sandy soils, there was a slight increase in growth. In all other comparisons trees receiving potash made less growth than those not so treated. In loam soils, the greatest total growth was obtained with Cyanamid at the rate of 700 pounds per acre in both high and low moisture soil. Again, trees grown without potash made better growth than those grown with this fertilizer, with one exception, when potash was added to Cyanamid at the rate of 300 pounds per acre in a low moisture treatment.

Considering all treatments, the greatest total growth was made in the loam soil and the least in sand, and trees without potash made better growth than those with potash. This detrimental effect of potash was more pronounced under high than under low moisture conditions.

Table 1. Secondary growth in tub experiment 1936.

Treatment	Soil					
	Sand		Sandy Loam		Loam	
	Growth in cms. per tree	No. growing points per tree	Growth in cms. per tree	No. growing points per tree	Growth in cms. per tree	No. growing points per tree
High Moisture:						
700 lbs. Cy, 200 lbs. KCl	56.0	14.6	12.6	3.2	—	—
300 lbs. Cy, 200 lbs. KCl	—	—	—	—	—	—
700 lbs. Cy	43.0	7.2	—	—	—	—
300 lbs. Cy	—	—	—	—	—	—
Check	—	—	—	—	—	—
Low Moisture:						
700 lbs. Cy, 200 lbs. KCl	18.2	4.8	1.6	0.6	—	—
300 lbs. Cy, 200 lbs. KCl	—	—	—	—	—	—
700 lbs. Cy	14.3	3.0	—	—	—	—
300 lbs. Cy	—	—	—	—	—	—
Check	—	—	—	—	—	—

With respect to injury from the use of Cyanamid shown in Table 1, the following observations were made:

Trees receiving Cyanamid at rate of 700 pounds per acre, with or without potash, produced most "secondary growth" in sandy soils with a high moisture content and less in the same soil with a low moisture content. Again, in the sandy loam soil, trees receiving Cyanamid at the rate of 700 pounds per acre plus potash produced some secondary growth in the high moisture treatments and only a slight amount in the low moisture treatment. No secondary growth was made in any of the other treatments in the experiment.

The greater secondary growth associated with high moisture may be explained by the fact that at the beginning of the experiment, the tubs were allowed to become too dry, facilitating the formation of dicyanodiamide. Subsequent excess watering would carry this substance down into the root zone and produce injury to the tree.

Leaf counts made on August 4 brought out the following points in regard to defoliation:

(a) The addition of potash to fertilizer treatment did not increase or decrease defoliation.

(b) The greater amounts of Cyanamid (700 pounds per acre) produced more defoliation than smaller amounts (300 pounds per acre).

(c) In general, there was greater defoliation in low than in high moisture treatments. This effect of moisture was greatest in sandy soil and only slight in sandy loam and loam soil.

From these data, it would seem as if the excess Cyanamid was the prime cause of injury, and that the potash had little or no effect on such injury.

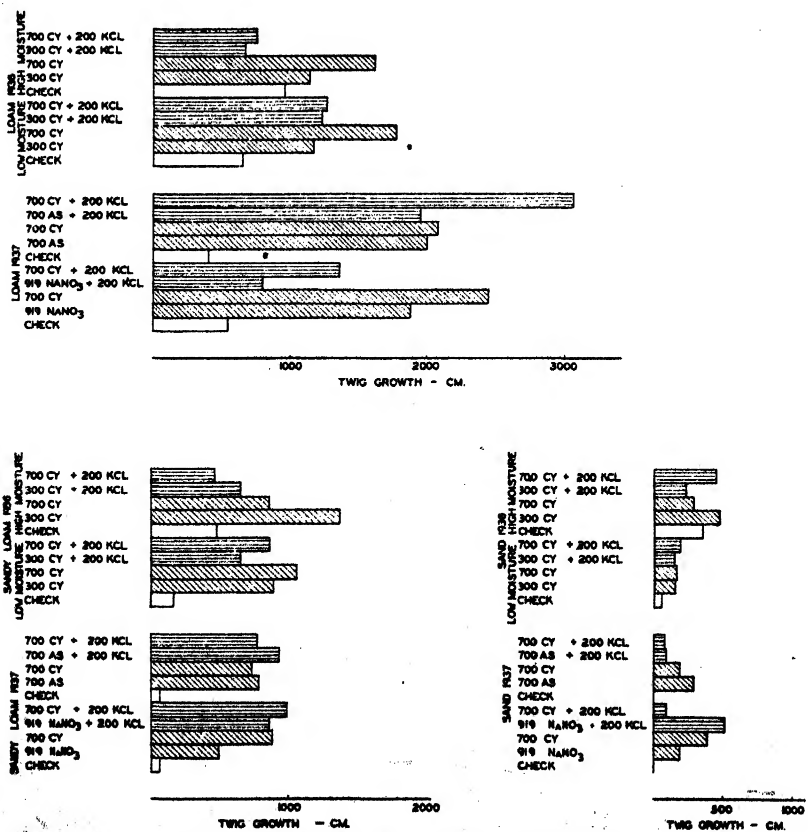

Fig. 2. Tub experiment. Total twig growth.

1937—Results in 1937 were measured by twig growth, blossom count, yield of fruit and general foliage conditions.

Total twig growth is shown in Fig. 2. The least growth was made by the several groups of check trees; in fact, in the sandy soil, these trees made no shoot growth at all. In sand, the addition of potash to trees receiving nitrate of soda produced a slightly better growth than those trees receiving nitrate of soda alone, but showed no beneficial effect in other comparisons. With trees growing in sandy loam, however, potash actually proved beneficial in every case in producing a slightly greater growth as compared with trees not receiving potash. In the case of trees grown in loam, only one comparison showed potash as being beneficial. Here, potash added to trees receiving Cyanamid and grown in a high moisture soil of the previous year produced the greater twig growth.

Foliage injury developed only on trees receiving Cyanamid fertilizer. In sand and sandy loam soils, the addition of potash did not reduce the burning in any way, trees receiving potash being just as badly burned as those which did not receive any of this fertilizer. In loam soils, where injury was not so severe, there was a slight indication

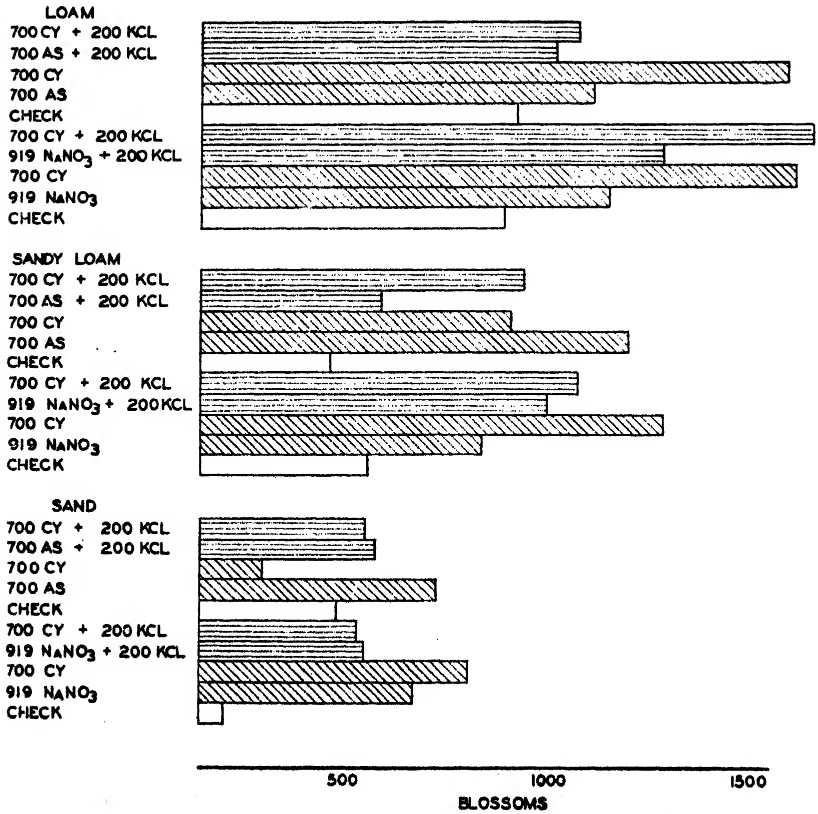

Fig. 3. Tub experiment. Number blossoms per tree.

that potash had reduced the amount of burning, but the evidence was too slight to justify any conclusion on this point.

Blossom production may be affected by soil and previous fertilizer treatment. To determine these effects, blossom counts were made in May and are shown in Fig. 3. When the various fertilizer treatments are grouped together, they show that those trees grown in sand produced 483 blossoms per tree, those grown in sandy loam produced 867, while those grown in loam produced 1,223 blossoms per tree. Clearly, the original soil had a marked effect on blossom production of these trees, due to or associated with the amount of vegetative growth produced by these different soils.

There seems to be no constant relationship between the addition of potash to the trees and blossom count, as can readily be seen by

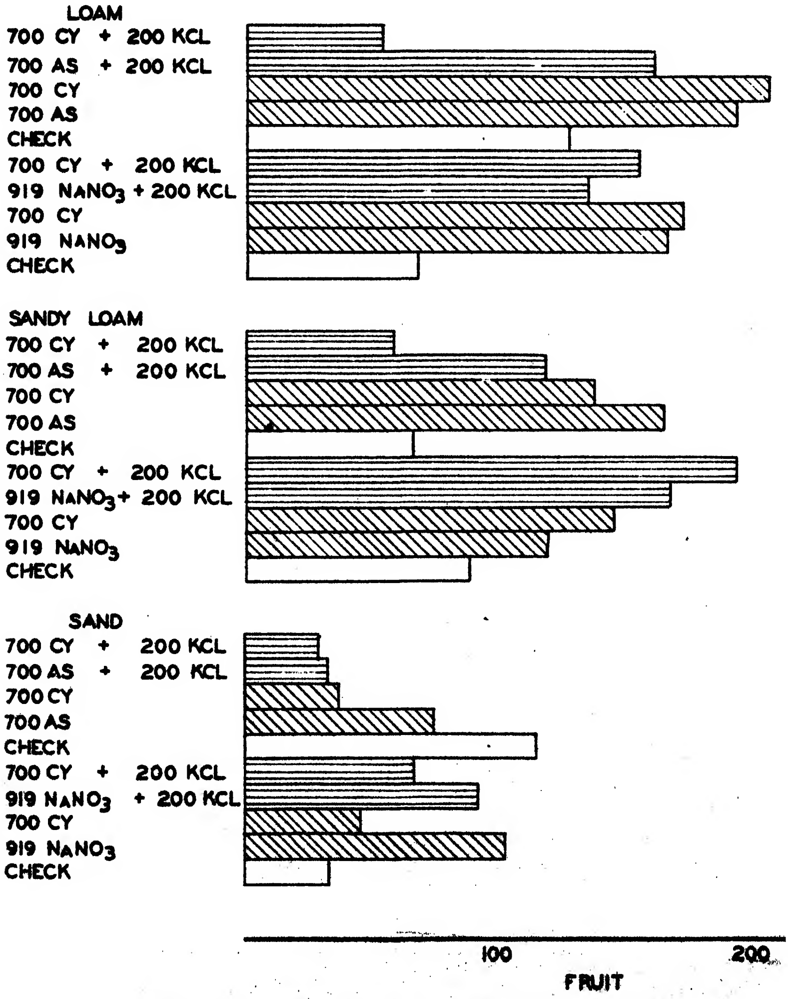

Fig. 4. Tub experiment. Number fruit per tree.

studying Fig. 3. In all but one case, the checks produced the least number of blossoms.

Fruit production, which would be affected by both the 1936 and 1937 treatments, is shown in Fig. 4.

Though the reduction in amount of fruit produced following potash application was slight and probably insignificant, the figures certainly afford no support to the belief that potash applications are likely to result in increased yield. Potash did not prove beneficial to the tree as far as the features measured were concerned. In fact, in several cases, it proved to be actually detrimental to the welfare of the trees.

Greenhouse Experiment

In order to make a further study of these fertilizers under a more completely controlled set of conditions, 100 cherry trees were grown in sand in the greenhouse, as already mentioned. Cyanamid and sulphate of ammonia were used with and without the addition of potash. The nitrogenous fertilizers were applied at the rate of 700 pounds per acre and potash at the rate of 200 pounds per acre. The trees were fertilized on February 3 and first showed injury on March 20. Foliage injury on trees receiving Cyanamid increased during the period of the experiment until by May 8, when the experiment was terminated, all the trees showed extensive foliage injury. This was evident whether or not the trees received potash along with the Cyanamid. Trees receiving sulphate of ammonia were in good condition on May 8 and possessed a healthy green foliage.

No growth comparisons were made because of the short period of the experiment and the fact that the trees were harvested on successive dates for chemical analysis.

The observations on the foliage reactions to the various treatments discussed above only help to confirm the conclusions based on the tub experiment that potash did not in any way alleviate the burning effect following Cyanamid applications, or improve the general condition of the trees.

Field Survey

In the fall of 1937, a survey was made of certain orchards in Michigan with the idea of trying to correlate tree performance with the potash content of the soil in which they were growing. Good and poor orchards were picked out and notes made on the general condition of the trees at the time when soil samples were obtained. Eighty-six soil samples were collected from the various fruit growing sections of the state at 6-inch and 12-inch depths and tested for available and reserve potash. The Spurway method of soil analysis was used in this work. Table 2 gives the results of these tests for reserve potash.

In general, the soils tested low in available potash and from low to high in reserve potash. Good, vigorous apple trees grew on soil containing just as much reserve potash as soil that produced poor trees. With peach trees, on the other hand, there was slightly more reserve potash in soil producing good trees than in soil producing poor ones. The best cherry trees also grew in soil containing slightly more reserve potash than in soil producing poor trees. The variation, however, was so great that these differences are hardly significant. Available potash

was low (0-30 pounds per acre) in nearly all cases and showed no relationship to growth.

From the data obtained in this survey, it seems very doubtful if the condition of the selected trees could be ascribed to the potash status of the soil.

The other factors in soil fertility were evidently of far greater importance in limiting growth than was the potash content of the soils.

Conclusion

The results obtained from these different experiments indicate that the use of potash cannot in any way counteract the foliage burning

Table 2. Potash content of orchard soils in relation to tree performance.

Apple Trees

	Reserve Potash in Soils (lbs. per acre reserve potash)								
Tree Performance..........	Good			Fair			Poor		
	No. of Orchard	Depth of Sampling 6"	Depth of Sampling 12"	No. of Orchard	Depth of Sampling 6"	Depth of Sampling 12"	No. of Orchard	Depth of Sampling 6"	Depth of Sampling 12"
	3.......	155	160	16.......	100	60	1.......	140	120
	5.......	125	105				2.......	140	120
	15.......	35	35				4.......	60	25
	18.......	160	160				13.......	45	40
	19.......	70	75				14.......	60	55
	35.......	20	10				17.......	155	145
	42.......	170	115				32.......	65	120
							33.......	50	30
							38.......	125	175
							40.......	35	50
Average.............	....	105	94.3	....	100	60	....	87.5	88.0

Peach Trees

	Reserve Potash in Soils (lbs. per acre reserve potash)								
Tree Performance..........	Good			Fair			Poor		
	No. of Orchard	Depth of Sampling 6"	Depth of Sampling 12"	No. of Orchard	Depth of Sampling 6"	Depth of Sampling 12"	No. of Orchard	Depth of Sampling 6"	Depth of Sampling 12"
	7.......	75	60	20.......	50	50	6.......	50	50
	9.......	50	55	21.......	30	40	23.......	30	50
	22.......	45	30	31.......	50	45	26.......	75	35
	24.......	90	90						
	27.......	85	75						
Average..........	....	69.0	62.0	....	43.3	43.3	....	51.7	45.0

Cherry Trees

Tree Performance	Reserve Potash in Soils (lbs. per acre reserve potash)								
	Good			Fair			Poor		
	No. of Orchard	Depth of Sampling 6"	Depth of Sampling 12"	No. of Orchard	Depth of Sampling 6"	Depth of Sampling 12"	No. of Orchard	Depth of Sampling 6"	Depth of Sampling 12"
	29	130	50	37	55	45	30	175	110
	36	190	120				34	35	30
	43	75	75						
	44	240	165						
	45	35	35						
	46	130	50						
	47	50	25						
	48	185	60						
Average		129.4	72.5		55	45		105	70

resulting from late spring applications of Cyanamid. It also does not appear that potash is as yet a limiting factor in tree fruit production in Michigan.

OBSERVATIONS ON CERTAIN COATINGS USED IN GRAFTING THE APPLE

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Protective coatings have long been used in grafting to seal the freshly cut tissue at the point of union of stock and cion. The main objective has been to prevent drying, though probably the coating likewise aids in keeping out insects and fungi. Most of the older coatings were grafting waxes of the so-called "hand wax" type. That is, they were more or less plastic or putty-like at working temperatures (40°-65° F.) and were applied by spreading over the surfaces to be covered by means of hand pressure. More recently the hand waxes have been gradually replaced by so-called "brush" waxes—materials that upon heating to 150°-200° F. are fluid and that consequently can be applied by means of a brush. The material preferably should be one that will adhere readily to either a moist or dry surface.

The black brush waxes that have largely replaced hand waxes have been satisfactory from the standpoint of covering and protecting the tissues to which they have been applied, but they have been comparatively expensive and require the added cost and trouble of a heating device to keep the wax in a brushing consistency. The difficulty of keeping wax warm has undoubtedly been the main factor that has caused investigators, nurserymen and manufacturers to search for a cold brushing mixture that would not injure plant tissue.

This article is a report upon experiments conducted with a number of different waxes, some of them proprietary materials sold under various trade names and others preparations made from formulae that will be given.

Methods and Materials

Fig. 1. The girdled section of a bridge-grafted tree coated with the standard home-made wax (No. 1), after weathering. The wax afforded protection early in the season, but owing to later cracking it is no longer of much value.

At the Graham Experiment Station near Grand Rapids, a nursery planting of young apple trees was available for these tests. It consisted of most of the standard apple varieties grown commercially in Michigan, together with a number of seedlings. For the most part the cleft graft was used on stocks ranging from three-fourths to one and one-half inch in diameter. The cions were not secured by tying but depended entirely on the pressure exerted by the split stock and the adhesive force of the wax to hold them in place.

Home-made Waxes—A home-made wax formula that has been in use for many years (5 lbs. resin, 1 lb. beeswax, ¼ pint raw linseed oil and ½ lb. powdered charcoal) was used as a standard with which to compare other materials. This is Wax No. 1, as given in Tables 1, 2, and 3. Various modifications of this formula were tried (see Table 1), e.g., using a smaller proportion of resin in Wax No. 2, using varying amounts of abietic acid in place of the resin in Waxes Nos. 3, 4, 5, and 6, doubling the amount of linseed oil and replacing the powdered charcoal with lampblack in Wax No. 19, and substituting Fuller's Earth for the powdered charcoal in Wax No. 20. These changes in formulae re-

sulted in some change in the melting or flow point of the several waxes and likewise in their susceptibility to cracking upon being exposed to the weather.

Commercial Trade or Proprietary Materials—Nine different trade or proprietary materials were used in the 1936 apple grafting trials and six in the 1936 pear trials. Five such materials were used in trials on

Fig. 2. The girdled section of a bridge-grafted tree coated with one of the proprietary preparations (No. 10), after considerable weathering. Notice that thus far it shows no cracks.

the apple in 1937, three of which had been used in 1936 and two of which were used for the first time in 1937. Information is not available as to their composition, nor is it known whether all or any one of them was the same in composition in 1937 as in 1936. They were simply obtained as samples of products being offered to the trade as grafting wax substitutes and for wound coverings. Some of them were obviously asphalt emulsions. The label on No. 14 stated that it was

made from pure Gilsonite asphalt, to which graphite, asbestos and tung oil had been added.

Results Obtained

The relative value of any grafting compound or wound dressing used in connection with grafting can be judged to some extent by its

Fig. 3. One of the home-made waxes (No. 20) after a season's weathering. Note that it has neither cracked nor scaled off to any considerable extent.

(a) cracking, (b) melting and running off the graft and (c) the length of time during which it adheres to the treated surfaces under exposure to ordinary weathering influences. More important, however, is the possible injurious influence on the tissues of the stock or cion. This can be more or less accurately measured by the stand of the

Table 1. Comparison of graft coatings on apple—1936.

Wax	Material	Cions set No.	Cion stand per cent	Total average growth per cion cm.	Flow point °F.	Wax not cracking per cent
HOME-MADE WAXES						
1.....	Resin, 5 lbs.—Beeswax, 1 lb.—Raw linseed oil, ¼ pt.—Lampblack, ½ lb...........	285	88	68	204	60
2.....	Same as No. 1, except 2½ lbs. resin.......	107	93	91	186	3
3.....	Same as No. 1, except abietic acid replaced resin..............................	111	90	124	204	0
4.....	Same as No. 3, except ¾ as much abietic acid was used........................	119	92	110	150	0
5.....	Same as No. 3, except ½ as much abietic acid was used........................	84	76	90	141	0
6.....	Same as No. 3, except for twice as much abietic acid..........................	82	82	117	159	0
19.....	Same as No. 1, except oil was doubled and carbon black replaced lampblack........	64	95	158	133	18
20.....	Same as No. 19, except Fuller's Earth replaced black powder..................	64	97	156	131	38
COMMERCIAL TRADE OR PROPRIETARY MATERIALS						
7.....	"Static" asphalt emulsion................	90	96	121	—	0
8.....	Same, plus 4 per cent asbestos............	88	94	107	—	25
9.....	Same, plus 12 per cent asbestos...........	90	94	87	—	25
10.....	Foster's I. B. M. asphalt Dispersion.......	98	95	115	—	1
11.....	"Tree Seal" (western)....................	94	81	67	—	35
12.....	"Tree Seal" (eastern)....................	120	68	51	—	6
13.....	"Kelsanite" (asphalt-latex)...............	108	38	27	—	34
14.....	"Asgum Plastic"........................	108	40	21	—	68
15.....	"Tremco 909 Grafting Comp."............	100	None	—	—	100

Table 2. Grafting wax trials with apple—1937*.

Material No.	Cions set No.	Cions alive per cent	Total average growth per cion cms.
1..	42	100	116
7..	22	100	151
10..	20	100	96
15..	20	5	5
211..	12	92	119
A..	8	63	27

*No. 211: A thick wax known as "Standard Wax 211" was used as prepared by the manufacturer. It is too thick to be applied with a brush without thinning or heating and therefore it was applied by means of a spatula. It remained soft and plastic, seldom cracked and remained waterproof.

No. A: "Graftex", a new compound recently placed on the market. It is a greenish grey mixture, very plastic and sticky and appears to have a low melting point since it cools and warms rapidly with changes in temperature.

Fig. 4. The standard home-made wax (No. 1) after a season's weathering. It has cracked rather badly. If cracks develop before a good union between stock and cion has been effected, the cut surfaces and cracks should be rewaxed.

cions and the amount of growth that they make. Data on all of these criteria are presented in Tables 1-3 presenting the results obtained with apple grafts in 1936 and 1937, and with pear grafts in 1936.

It will be noted that from the standpoint of freedom from cracks most of the preparations were far from perfect, though despite this fault good stands of the cions were obtained. All of the home-made waxes gave satisfactory results, as judged by percentage stand of cions, and the amount of growth that they made. Several of the modifications of the standard formula (No. 1) appeared to be preferable to it, especially in view of their somewhat lower melting points. Home-made wax No. 20 seemed to be especially promising. Similarly several of the commercial trade preparations gave good results, though Nos. 12, 13, 14 and 15 cannot be recommended on the basis of these trials.

Table 3. Grafting wax trials with pear—1936.

Material No.	Cions set No.	Cions alive per cent
10	12	100
8	14	93
1	37	87
12	28	71
14	22	68
13	10	50
15	35	3

Fig. 5. Typical results attending the use of a wax that contains some injurious ingredient or combination. Note the sunken dead bark areas on the stock.

MAHALEB VS. MORELLO ROOT STOCKS FOR EARLY RICHMOND CHERRIES

WALTER TOENJES
Section of Horticulture

The cherry root stocks commonly used in the propagation of the sour cherry influence considerably the stature and form of tree of the variety worked upon them. The strong vigorous-growing Mazzard stock, when budded or top-worked to the sour cherry, produces a larger and stronger growing tree than does the smaller growing Mahaleb, though it is not generally recommended for Michigan conditions because its roots are more susceptible to winterkilling than are those of the Mahaleb. Morello stocks are not in common use in the United States, though there has long been considerable interest in them.

In the spring of 1931 a number of Early Richmond trees were planted at the Graham Horticultural Experiment Station near Grand Rapids, part of which were on Mahaleb and part on Morello roots. They were grown on the same type of soil and afforded the same cultural treatments. The trees on Mahaleb stock are upright-spreading in habit with relatively thick branches and shoots, while those on Morello stock

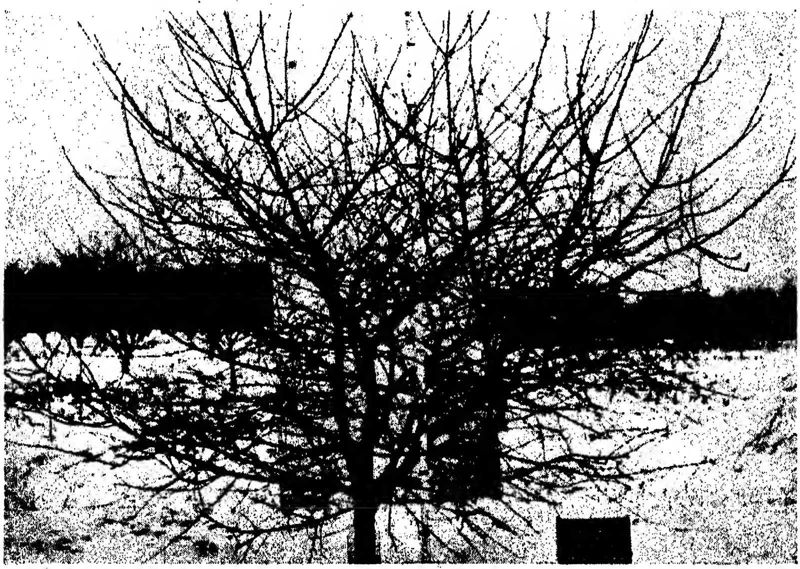

Fig. 1. Early Richmond on Mahaleb stock. Note the upright-spreading form of tree and its relative size and vigor as compared with the tree shown in Fig. 2.

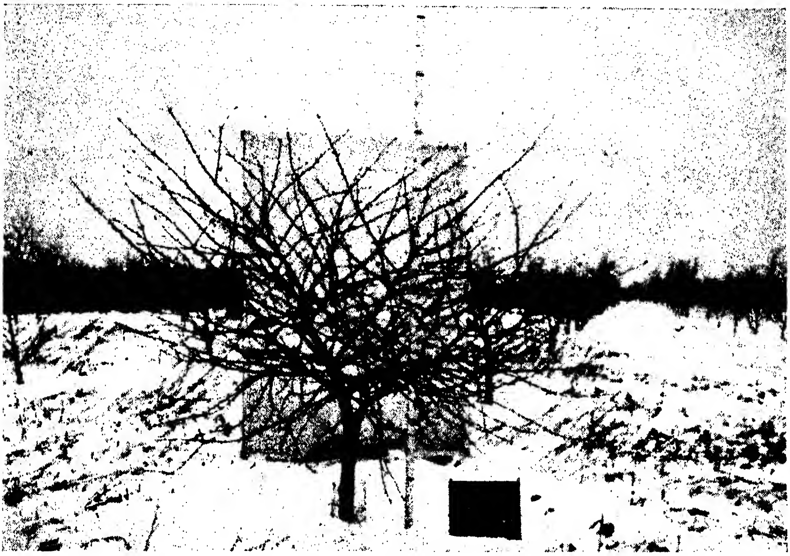

Fig. 2. Early Richmond or Morello stock. Note the low spreading habit of growth and its small size as compared with the tree shown in Fig. 1.

have assumed more or less the natural growth habit in stature and form of the Morello (See Figs. 1 and 2). They are smaller in size, spreading in form, with slender drooping branches and slender trunks. Tree growth measurements were made at the end of the seventh season. The trees on the Mahaleb had an average trunk circumference of 14.3 inches, an average tree height of 11.0 feet and an average branch spread of 13.5 feet. Similar averages for the trees on Morello stock were 8.5 inches, 7.0 feet and 9.1 feet, respectively.

Observations indicate that there is little or no difference in the size of the fruit as grown on these two stocks. The trees growing on the Morello stock showed a tendency toward earlier and somewhat heavier bearing than those on the Mahaleb stock, but this advantage is more than offset by the greater fruit bearing surface of the latter and their larger total yields. Though the Morello stocks may possess some advantage for trees raised in the home garden where space is limited, they do not seem to have a place in the commercial orchard.

KILLING TREES WITH KINDNESS

T. A. MERRILL
SECTION OF HORTICULTURE

The ultimate objective of every fruit grower is to grow strong, healthy, vigorous trees that will be long-lived and capable of bearing heavy crops of salable fruit. Attainment of their objectives depends on the selection of good varieties, planting the trees in a suitable soil,

Fig. 1. Southwest half of tree showing results from painting trunk with paradichlorobenzene dissolved in linseed oil. Leaves on the other half of the tree were badly wilted and dwarfed at the time picture was taken. This tree probably will not recover.

proper cultural practices, fertilization, insect and disease control, pruning and a number of other factors. If the trees do not measure up to expectations in growth and production, it is usually due to a failure on the part of the owner to provide for them the requisite environmental conditions and care. Not infrequently, however, he is too anxious for them to succeed and (thinking that if a little of some treatment or practice is good a lot will be better), he overdoes with fertilizer or with spray application or with cultivation or pruning or in some other manner. Attention is here called to instances where the writer has been called to diagnose the cause of serious trouble and suggest remedial measures.

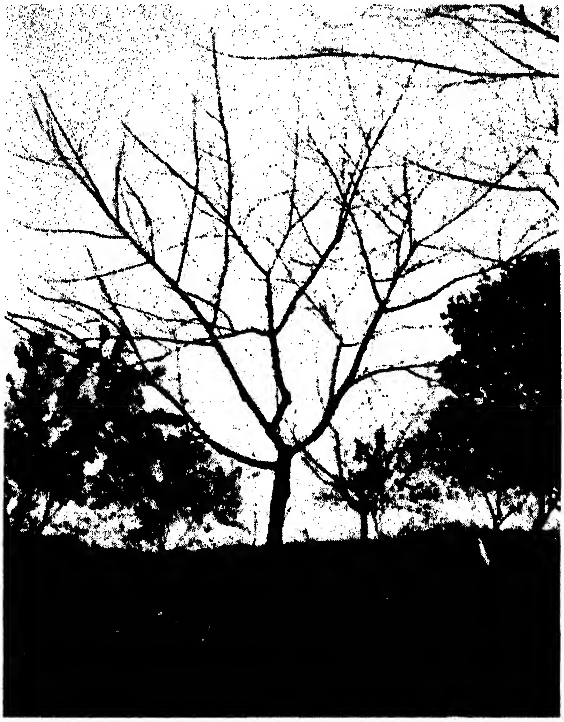

Fig. 2. This tree lost its leaves soon after growth started in the spring of 1938. The more serious injury on this tree than the one shown in Fig. 1 is due to smaller trunk diameter and thinner bark.

Spraying with Materials not Needed—Many unnecessary cases of arsenical injury have been observed on peaches, apples, and other tree and bush fruits. On one occasion the writer observed a two-year-old peach orchard in which most of the trees had been killed outright as a result of arsenical spray applications containing no corrective for arsenical injury. In the first place it is unnecessary to spray peach trees with an arsenical until they begin to bear fruit, for leaf eating

insects seldom trouble peach foliage. In the second place, zinc sulphate, or some other corrective, should always be added to the spray when arsenic in any form is used on peach foliage. Zinc sulphate has no insecticidal value and very little, if any, fungicidal value, but failure to use it usually results in serious foliage injury to peach foliage and twigs, premature defoliation and often death of the trees.

Fig. 3. Showing blackened condition of cambium after painting trunk of tree with paradichlorobenzene dissolved in linseed oil. The cambium was dead on all trees so treated at time pictures were taken.

Too Heavy Applications of Insecticides—A short time ago a peach grower complained because his peach trees were dying. Inspection disclosed that, though soil conditions seemed favorable and cultural operations seemed to have been properly carried out, only a few of the trees in a block of 300 had fairly normal leaves. A few trees had green leaves on one side but the leaves on the other side of the trees were dead (Fig. 1). Other trees were still in possession of their leaves but they were small, yellowish, and more or less wilted, and still other trees had lost all of their leaves (Fig. 2). The grower made the remark that shortly previous to the inspection he had never seen peach trees with better trunks and so free from gum. However, the trunks were off color and upon examination it was found that the cambium was dead—apparently only recently killed. During the summer of 1937 there had been some borer injury and in the fall the grower decided to treat all his trees to stop the trouble. To do this he dissolved paradichlorobenzene in linseed oil, because cottonseed oil, which should be used, was a little more expensive. Thinking that if a little of the material would be good a lot would be better, he painted with it the entire trunks of all the trees from the ground level to the crotches. In drying, the oil formed a kind of "skin" and the fumes of the crystals penetrated the bark and killed the cambium (Fig. 3).

Paradichlorobenzene has its place in the control of fruit tree borers—but not dissolved in linseed oil and applied as this fruit grower applied it. The application of paradichlorobenzene dissolved in raw cottonseed

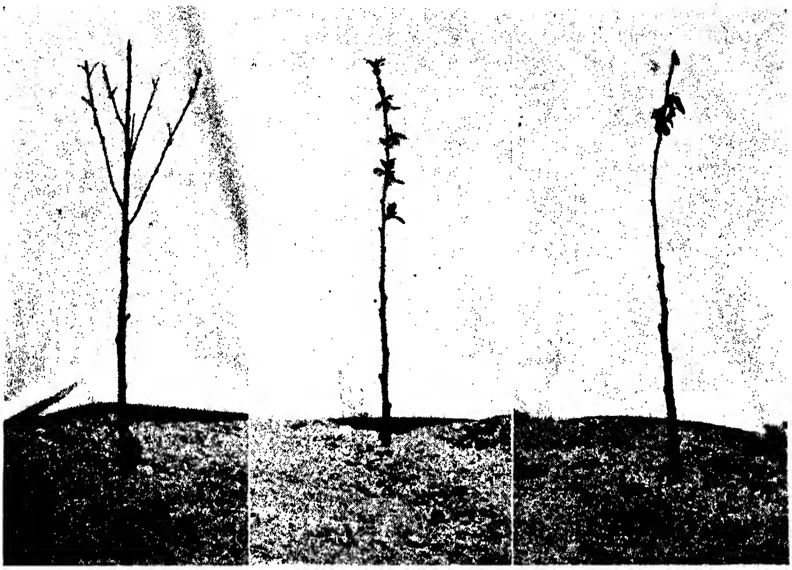

Fig. 4. "A" shows Montmorency tree planted in spring of 1937 to which one-fourth pound of ammonium sulphate was added to soil at time of planting. "B" and "C", trees that were re-set in 1938 to which sulphate was also added to soil at time of planting. At the time the pictures were taken leaves were badly burned and root cambium was dead.

oil anytime between September 1 and April 15 will control the lesser borers which work in the trunk, crotches, and large limbs of the peach tree. It should not be applied, however, when the temperature is 50° F. or below, as the material will crystallize. The mixture—one pound of paradichlorobenzene dissolved in two quarts of raw cottonseed oil—painted upon the infested areas (never around the entire branch or trunk) after removal of the gum will kill practically all of the borers. If it is applied without removal of the gum it will kill about 90 per cent of them.

Too Much Fertilizer—On another occasion one nurseryman stated that a fruit grower with whom he had done business for a number of years had planted a small block of Montmorency cherry trees in the spring of 1937. In the spring of 1938 most of the trees were dead and the grower believing the nurseryman to be at fault in supplying trees with which something had been the matter, asked the nursery to replace them. When the writer was called into consultation by the grower and nurseryman, many of the trees that were planted in 1938 were dying. Tip and marginal burning of the leaves was prominent. Many leaves were dead, some had fallen. In some trees the cambium layer was dead and their roots had turned black. The writer suspected that the injury may have been due to too heavy an application of fertilizer.

Upon questioning the grower admitted, rather reluctantly, that both seasons he had applied sulphate of ammonia at the time of planting. He added, "Well, gentlemen, now I will tell you just why I added sulphate to those trees. Mr. X, a competitor of yours (the nurseryman) told me he could sell me better trees. Inasmuch as I had done business with you for a number of years, I more or less wanted to prove that he was mistaken in his statement. With this idea in mind, I decided that a little sulphate would help the trees out." Fertilizer application may be desirable the year that trees are planted, depending on conditions, but anyone using it should remember that the root system is confined to a very small area and anything more than a very light application to that area is likely to result in a toxic concentration that may cause burning or even be fatal to the tree.

This article is not written with the idea of discouraging the use of the materials mentioned, but to caution against the killing of trees with kindness. These materials and all others that have their place in the orchard should be used with caution, in the proper amounts and at the proper time.

BULLETIN REVIEWS

Circ. Bul. 166.—Water Conditioning for Greenhouses.—Spurway, C. H. and Wildon, C. E.—A progress report on a method of water conditioning for greenhouses, lawns and gardens in order to maintain suitable degrees of acidity or alkalinity in the soil. The installation and operation of the apparatus, which neutralizes the carbonate hardness of the water with phosphoric acid, is described. (10 pp., 1 table, 2 figs.)

Tech. Bul. 159.—The Manganese Content of Feedstuffs and Its Relation to Poultry Nutrition.—Schaible, P. J., Bandemer, S. L. and Davidson, J. A.—Perosis, or slipped tendon, in chickens is shown to be caused by either a deficiency of manganese in the ration or an excess of mineral concentrates which reduced the availability of this element.

The minimum manganese requirement for chicks and hens on normal mineral rations was determined to be approximately 40 mg. per kg. of ration.

All compounds and ores of manganese used were found satisfactory as supplements except the ores rhodonite and rhodochrosite; the oxide ores were the most economical.

A wide variety of feedstuffs was analyzed for manganese and the concentration was found to vary with such factors as species of plant, time of harvest, stage of maturity, fertilization and soil reaction. Because of this variation, it is recommended that poultry rations be augmented with manganese in order to insure a sufficiency of this element at all times. A compilation of the results of the analyses of feedstuffs for manganese is given in an appendix. (32 pp., 18 tables.)

Tech. Bul. 160.—Physiological Investigations of Red Raspberry Plants Inoculated with Red Raspberry Mosaic.—Grigsby, B. H.—Red raspberry plants inoculated with the virus causing red raspberry mosaic exhibit the usual mottling of a mosaic disease under relatively cool temperature conditions. When the temperature is 75° F. or above the symptoms are masked and the leaves appear normal.

In all plants in which the virus was present chlorophyll content was somewhat greater than in healthy plants. In virus-infected plants the formation of extra layers of chlorophyll-bearing palisade tissue was observed and could account for the increased chlorophyll content. Sucrose was present in increased amounts and all other carbohydrates in decreased amounts in diseased as compared with healthy plants.

Nitrogen studies demonstrated the presence of more total nitrogen in the healthy plants but more ammonia nitrogen in mosaic-infected plants. This indicates that the virus had interfered with the process of protein synthesis.

It was found that the rate of photosynthesis was decreased in plants having marked symptoms of the disease and progressed more rapidly in normal plants. Respiratory rate, on the contrary, was increased in the virus-infected plants. Seasonal variations were demonstrated for both processes.

Rate of water loss by transpiration was highest in those plants infected with the virus.

Stomatal counts showed a greater number per unit area on the diseased leaves. Such leaves, however, are usually smaller than healthy leaves of the same age. Analyses of the ash of leaf tissue showed a greater percentage of ash in tissue taken early in the morning than in similar tissue taken late in the afternoon. It is suggested that the progressive dwarfing of canes in an infected planting is due to the fact that the virus slows down photosynthetic processes and speeds up respiratory activity. Thus the infected plants are starved and eventually die. (27 pp., 11 tables, 4 figs.)

Memoir 3.—Studies on the Trematode Parasites of Ducks with Special Reference to the Mallard.—Gower, W. Carl.—The report is divided into two parts, the first, dealing with trematodes found in Michigan ducks, the second, a check-list of all species of trematodes reported from ducks.

More than 200 ducks, coming from seven widely scattered areas in Michigan were examined. From these ducks, 15 species of trematode worms were recovered, three of which are named as new species. One new genus is described. Artificial infections were obtained in the case of four species. *Amphimerus elongatus* n. sp. is considered the most important pathogene to the hosts. This fluke, living in the pancreas and liver of ducks, causes considerable damage, especially to young ducks. Partial life history records of *Amphimerus elongatus* and *Zygocotyle lunatum* were obtained. In general, under normal conditions, the trematodes studied have little pathological effect on the host. However, as in the case of practically all internal parasites, when unusual complications or the normal host-parasite balance is upset, serious damage to the host may result.

The second part of the report is a compilation from the literature of the trematodes that have been recorded from ducks, and includes 109 species belonging to 46 genera and 17 families. A key to the genera, and a host list are also included. Family and generic diagnosis are given, with the species listed under the genera. Principal synonyms, hosts, distribution, and life history notes (where known) are given for each species. (94 pp., 3 figs.)

JOURNAL ARTICLE ABSTRACTS

A Bottle Sterilizer for Small Capacity Plants.—Marshall, Roy E.—Fruit Prod. Jour. 18 (1): 8-9. 1938. [Journal Article No. 175 (n. s.) from the Michigan Agricultural Experiment Station.]—Directions are given for the construction of a U-shaped metal tube through which beverage bottles may be passed for sterilization in a hypochlorite solution. The sterilizing tube, when operated at a capacity of 225 quart bottles per hour, permits two bottles to fill with the sterilizing solution and two to empty simultaneously and the length of the tube is such that 2½ minutes elapse from the time a bottle is completely filled with chlorine solution until it is fully drained. Observations indicate

that the bottles were completely sterilized in this time. Suggestions are given for the construction of units having greater capacity.

The Microscope in the Production of High Quality Milk.—Bryan, C. S., Turney, G. J., Fox, W. K., Begeman, L. H., Miles, X. A. and Bryan, J. S.—Jour. of Milk Technology. 1(5): 26-34. 1938. [Journal Article No. 327 (n. s.) of the Michigan Agricultural Experiment Station.]—This study was undertaken to determine the original source of the bacteria found in poor quality, high count raw milk, and, utilizing this information, to suggest the probable source of contamination to the dairyman in order that he may correct or improve his procedure of milk production. The milk samples were checked by quality tests for milk in addition to the microscopic examination. The results of the methylene blue reduction test, sediment test, direct microscopic count, and temperature readings of the milk as it arrives at the plant were utilized in arriving at a score on a patron quality report.

The majority of raw milk samples having a count of less than 100,000 bacteria per c.c. (class I) were of class 1 methylene blue and classes 1, 2 and 3 of the sediment test. Practically all of this milk arrived at the plant at a temperature of 60° F. or lower and with a passing score, while during the warmer summer months the temperature was higher and the number of milk samples with a score below passing increased.

The samples in class II of the microscopic examination (100,000 to 500,000 bacteria per c.c.) were in class 2 and some in class 3 of the methylene blue test, and in classes 2 and 3 of the sediment test. Dirty utensils, poor cooling, and dirty cows or barn were the major sources of contamination in this group. A number of the samples had a temperature of 65° F. or above. Approximately 50 per cent of this milk had a passing score.

The bulk of milk sent to Lansing over a six months period was of Class I and II on the basis of the bacteria count. When the bacteria count was in class III (500,000 to 1,000,000), the methylene blue rating dropped to classes 2, 3, and 4, with the greatest portion of the milk showing a larger amount of visible dirt as indicated by the sediment test. In addition to individual cases where poor cooling, utensils, dirty cows, or barn were the chief sources of contamination, the types of microbes found in many samples would indicate the necessity of a thorough cleanup of all phases of milk production, and is indicated on the score card as poor production. The temperature of this milk was high, and practically none of this milk rated a passing score. The milk with a count of more than 1,000,000 per c.c. (class IV) was mainly of classes 3 and 4 methylene blue, and 2, 3 and 4 sediment test. The types of contamination responsible for this high count milk were similar to those of class 3 (microscopic count). The temperature of most of this milk as it arrived at the receiving plant was above 65° F. and none rated a passing score.

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NATURE OF PUBLICATIONS—

Four series of publications are issued by the Experiment Station—Special, Circular, Technical, and Quarterly. In addition to these the Extension Service issues its regular series, as well as those of the club service.

Special bulletins are of a popular nature, and deal with special lines of work.

Circulars are briefly and concisely written discussions of a popular nature.

Technical bulletins, as the name implies, are devoted to reports of scientific research and designed more especially for use of other investigators, instructors and students.

The Quarterly bulletin contains contributions by all sections of the Experiment Station. It is issued during February, May, August, and November of each year. The Quarterly also contains a list of available bulletins.

MAILING RESTRICTIONS—

Single copies of bulletins are for free distribution as long as the supply lasts. Quantities of bulletins may be obtained at cost.

Requests for bulletins should be limited to those actually needed.

Bulletins are not intended to be used as text books in classes, but, upon application, libraries of colleges and public schools of Michigan will be supplied with a few copies for class reference.

All applications for bulletins should be addressed to V. R. GARDNER, DIRECTOR, East Lansing, Michigan.

LIST OF AVAILABLE BULLETINS

Regular Bulletins—

R-262 Suggestions on Planting Orchards.

Special Bulletins—

S- 71 Studies in the Range and Variation of the Per Cent of Butterfat in the Milk of Individual Cows.
S- 83 Key to Orthoptera of Michigan.
S- 94 The Financial History of a Twelve-Year-Old Peach Orchard.
S- 98 Vinegar.
S-101 Oats in Michigan.
S-106 Sugar Beet Growing in Michigan.
S-109 Crop Varieties for Michigan.
S-110 Special Report of the Upper Peninsula Experiment Station.
S-124 The Colorimetric Hydrogen-ion Determination as a Means of Locating Faulty Methods at City Milk Plants.
S-126 An Analysis of the Peach Variety Question in Michigan.
S-130 The Clovers and Clover Seed Production in Michigan.
***S-133 Fertilizers—What They Are and How to Use Them.**
S-141 Profitable Pruning of the Concord Grape.
S-142 Grafting in the Apple Orchard.
S-150 Emergency Hay and Pasture Crops.
S-151 Buckwheat in Michigan.
S-153 Peppermint Growing in Michigan.
S-156 Investigation With Strains of Beans.
S-164 Diagnosing Orchard Ills.
S-167 Chicory Growing in Michigan.
S-170 The Detroit Milk Market.
S-171 Farmers' Co-operative Buying and Selling Organizations in Michigan.
S-172 Farm Real Estate Assessment Practices in Michigan.
S-175 The Rural Cemetery.
S-178 Michigan Raspberry Diseases.
S-180 The Soils of Michigan, Grayling Sand.
S-182 Strawberry Growing in Michigan.
S-184 Size of Peaches and Size of Crop.
S-185 Roadside Marketing in Michigan.
S-189 The Marketing of Michigan Milk.
S-190 Oak Forests of Northern Michigan.
S-191 Barley for Michigan Farms.
S-192 Causes and Effects of Soil Heaving.
S-194 The Use of Peat in the Greenhouses.
S-195 Maintaining the Productivity of Cherry Trees.
S-196 The Farm Woodlot in Michigan.
S-197 Oat Tests at the Michigan Experiment Station.
S-198 Combine Harvester Threshers in Michigan.
S-199 Studies in Swine Feeding, Parts I, II, III.
S-200 Hogging Off Corn.
S-201 The Influence of Sugar and Butterfat on the Quality of Ice Cream.
S-203 Spraying Materials and the Control of Apple Scab.

*Bulletins listed in bold face type are recent publications of this Station.

S-204 Investigations of Corn-Borer Control at Monroe, Mich.
S-205 Soil Fertilization for Sugar Beets.
S-207 Public Health and Educational Service in Michigan.
S-208 Service Institutions and Organizations in Town-Country Communities.
S-209 Consumer Demand for Apples in Michigan.
S-210 Corn Growing in Michigan.
S-213 Investigations with Oat Varieties and Diseases.
S-214 Insects and Allied Pests of Plants Grown Under Glass.
S-215 Successful Farm Practices in the Upper Peninsula.
S-217 Marketing Michigan Beans.
S-218 Spray Injury Studies No. I.
S-219 Spray Injury Studies No. II.
S-220 Comparisons of Methods of Making Spray Applications.
S-221 Controlling the Codling Moth in Southwestern Michigan.
S-222 Garden Roses.
S-223 Bald Rock Wheat.
S-226 Activities of Churches in Town-Country Communities.
S-227 Motor Truck Marketing of Michigan Fruits and Vegetables.
S-228 The Rock Garden.
SS-228 Supplement—List of Rock Garden Plants.
S-229 Rural School Organization in Michigan.
S-230 Success and Failure in Spraying for Scab and Codling Moth.
S-231 Agricultural Land Classification and Land Types of Michigan.
S-232 The Michigan Pear Industry, Its Status and Trends.
S-233 Experimental Studies in Feeding Fattening Lambs.
S-234 Spraying and Dusting Potatoes in Michigan.
S-235 Motor Truck Marketing of Michigan Livestock.
S-236 Population Trends in Michigan.
S-237 Trends in Cherry Production in Michigan.
S-238 Some Wood Borers Attacking the Trunks and Limbs of Deciduous Trees and Shrubs.
S-239 The Principal Grape Insects in Michigan.
S-241 A Farm Management Study of Crop Production Practices.
S-242 Grape Production Costs and Returns in Southwestern Michigan.
S-243 Important Leaf Feeding and Gall Making Insects Infesting Michigan's Deciduous Trees and Shrubs.
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S-257 Utilization of Land Types for Fruit Production, Berrien County, Michigan.
S-258 Production and Price Trends in the Pitted Red Cherry Industry.
S-259 The Influence of the Length of the Interval Between the Pickings on the Yield and Grade of Pickling Cucumbers.
S-260 Yellow Dwarf Disease of Potatoes.
S-261 Changes in the Retail and Service Facilities of Rural Trade Centers in Michigan, 1900 and 1930.
S-262 The Use of Cleaners in the Dairy Plant.
S-263 The Production-Consumption Balance of Agricultural Products in Michigan. Part I. Fruits and Vegetables.
S-264 Farm Tax Delinquency in Michigan from 1928-1932.
S-265 The "Thin Wood" Method of Pruning Bearing Apple Trees.
S-266 Dahlias.
S-267 An Economic Study of the Potato Enterprise in Michigan.
S-268 Public Produce Markets of Michigan.
S-269 The Production-Consumption Balance of Agricultural Products in Michigan. Part II. Livestock and Animal Products.
S-270 The Economics of Bean Production in Michigan.
S-271 The Katahdin Potato in Michigan.
S-272 The Disposal of Wastes from Milk Products Plants.
S-273 The Production of Cucumbers for Pickling Purposes.
S-274 Changes in Standards of Consumption During a Depression.
S-275 Factors Influencing the Yields of Montmorency Cherry Orchards in Michigan.
S-276 Field Stacking for Michigan Beans.
S-277 Insecticide Experiments on Codling Moth in Michigan, 1929-1935.
S-278 The Production-Consumption Balance of Agricultural Products in Michigan. Part III. Field Crops.
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*As of June 30, 1938.

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MEASURING HYBRID CORNS FOR MICHIGAN

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SECTION OF FARM CROPS

No method of breeding has offered the possibilities for marked improvement in the productive and physical attributes of corn as the method, now widely used throughout the United States, of mating together carefully chosen inbred lines to produce hybrid vigor.[1] However, it must be borne in mind that the term, "hybrid corn" is not merely the name of another corn variety but that it is the general term applied to a great number of corn varieties resulting from a particular method of breeding. There is just as much variation among the different hybrids as there is among the usual open-pollinated varieties.

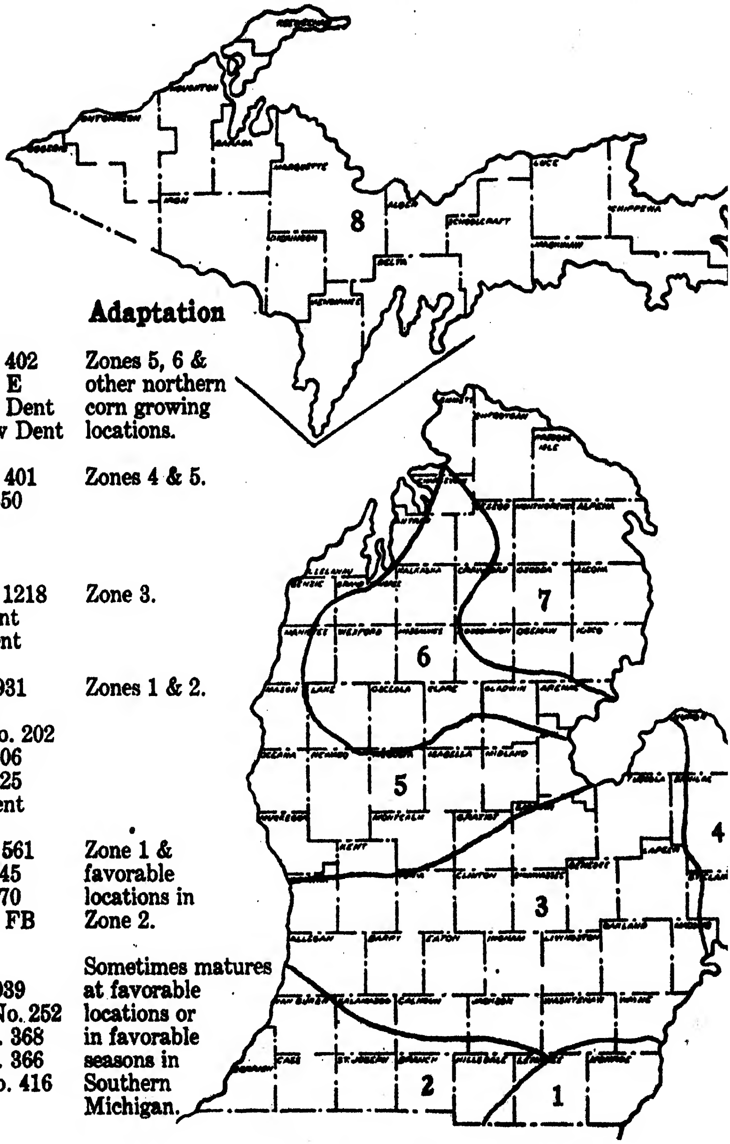
Plant breeders, in developing the different lines of hybrid corn have been able to eliminate many undesirable characteristics more effectively than was true by ordinary selection methods used in developing the standard open-pollinated varieties such as Leaming, Reid's Yellow Dent and similar corn belt varieties, or Duncan, Golden Glow, and Pickett, open-pollinated varieties commonly used in Michigan. Thus, good hybrids are characterized by stiff stalks; well developed, healthy roots; a marked uniformity of kernel, ear and plant characteristics, and superior vigor and productivity.

Assuming that most of the hybrid corns now offered commercially are the result of good plant breeding methods and careful production on the part of hybrid seed growers, these hybrids still are vastly different in value for any given location. Some hybrids are early enough to mature regularly in the most northern corn growing sections of Minnesota, Wisconsin, and Michigan; others are so late as to require the full growing season of the heart of the corn belt in Iowa and Illinois. No grower can expect superior or even average performance from hybrid corn unless he plants the seed of a hybrid adapted to his particular soil and season.

Adaptation of Hybrids Tested

For the purpose of testing the adaptation of promising hybrids developed at the Michigan Agricultural Experiment Station and to aid in evaluating hybrids developed elsewhere (many of which are offered for sale in Michigan), the Farm Crops Section has for the last four years conducted a series of over-state trials of a large number of corn hybrids. Cooperation in this work has been extended by county agricultural agents, farmers, the Michigan Crop Improvement Association,

[1]For a detailed discussion of hybrid corn, the breeding and production methods used, and the kinds of improvement which this breeding method makes possible, write to the Bulletin Room, Michigan State College for Michigan Extension Bulletin 195: "Hybrid Corn and Its Place in Michigan".



Varieties	Adaptation
Minn. Hybrid No. 402 Kingscrost Hybrid E Northwestern Red Dent Wis. No. 25 Yellow Dent	Zones 5, 6 & other northern corn growing locations.
Minn. Hybrid No. 401 Wis. Hybrid No. 350 Golden Glow Kingscrost E,	Zones 4 & 5.
Mich. Hybrid No. 1218 Pickett Yellow Dent M.A.C. Yellow Dent	Zone 3.
Iowa Hybrid No. 931 Ohio Hybrid K-23 DeKalb Hybrid No. 202 Wis. Hybrid No. 606 Wis. Hybrid No. 525 Duncan Yellow Dent	Zones 1 & 2.
Mich. Hybrid No. 561 Wis. Hybrid No. 645 Wis. Hybrid No. 570 Kingscrost Hybrid FB	Zone 1 & favorable locations in Zone 2.
Ohio Hybrid W17 Iowa Hybrid No. 939 Nebraska Hybrid No. 252 Illinois Hybrid No. 368 Illinois Hybrid No. 366 Indiana Hybrid No. 416	Sometimes matures at favorable locations or in favorable seasons in Southern Michigan.

The information presented on this page is designed to aid Michigan farmers in selecting adapted corn varieties and hybrids. The zoning of the map of Michigan is based on a study of records of the normal weather during the corn growing season in this state. The adaptation of corn varieties is influenced by soil, cultural practices and other factors besides weather so the zone divisions must be considered as general approximations rather than anything more specific. The varieties listed have been observed in several Michigan trials and the comparative moisture content of the grain at harvest time, and other kinds of information pertinent to relative time of maturity have been noted. For further information as to the relative merit of different varieties and hybrids, corn growers should study the more detailed information presented in this publication.

corn breeders of other states, and seedsmen. These trials have been located in southeastern Michigan (Monroe County), southwestern Michigan (St. Joseph County), central Michigan (Ingham and Saginaw counties), the Thumb District (Huron and Tuscola counties), and northern Michigan (Wexford and Otsego counties).

In each trial the corn strains tested are planted in three-row plots ten hills long. There are five such plots of each strain, the plot arrangement being altered for each series in order to reduce to a minimum the influence of soil variations on the comparative performance of the various strains. Observations are made of growth characteristics, relative time of maturity and other factors; the center row of each plot is harvested for total green weight to give an indication of the relative silage value of the different lines of corn; and finally, at the end of the growing season, the two outside rows are husked, the grain weighed, its moisture content determined, and comparative acre yields are calculated on the basis of bushels of shelled corn at 14 per cent moisture.

An annual report of these trials in mimeographed form is issued for all cooperators. However, the performances of a hybrid or any variety in a single test or in tests of a single season are entirely inadequate to establish the true value of that line. The soils in a single test plot vary—in some cases this variation is exceedingly large, seasons vary tremendously, and hybrids themselves are by no means 100 per cent uniform in their performance. Therefore, a series of tests over a period of years is required as a basis for establishing the merit of any particular line with reasonable assurance.

In this publication there is summarized, insofar as possible, the results of four years of over-state corn trials. Where two varieties have been compared in seven trials over the full four-year period, as in the case of Duncan and Michigan Hybrid No. 561, the reliability of the comparison is much greater than in the case of varieties compared in only three trials over a two-year period, as with Michigan Hybrid No. 561, and Wisconsin Hybrid No. 606. Presented in this publication are results of comparisons made in not fewer than three trials and covering not fewer than two seasons. Many hybrids, some of which are probably well adapted to certain Michigan conditions, have appeared in fewer than three of these trials and in no more than one season. The performance of such hybrids is not presented in this publication but will be presented at some future time when those hybrids have been tested further and a more adequate basis for evaluating their performance has been obtained.

Seed of Certain Hybrids of Proven Value is Certified by the Michigan Crop Improvement Association

In order that Michigan corn growers may have adequate sources of reliable seed of certain hybrids of proved merit, the Michigan Crop Improvement Association, under the supervision of the Farm Crops Department of the Michigan State College, conducts inspection and certification of such seed. Parent stock for hybrids, seed of which is certified for 1939 by the Michigan Crop Improvement Association was produced by the Farm Crops Department of Michigan State College. Certification, based on field and seed inspection, gives assurance as to adequate isolation of the hybrid seed-producing fields, thorough and

timely detasseling of the seed producing parent plants, drying, reasonable grading, and strong germination of the seed.

The seed of five good hybrids was inspected and certified by the Michigan Crop Improvement Association in 1938, and is available for 1939 plantings. A description of these hybrids and their adaptation follows:

Michigan Hybrid No. 561—Adapted for grain production to the stronger soils in the southern tier of Michigan counties, especially southeastern Michigan. Adapted for silage production as far north as Saginaw, Tuscola, and Huron counties, but too late for grain production in central Michigan, except under most favorable circumstances.

Michigan Hybrid No. 561 produces a large leafy plant with a heavy strong stalk which has stood up well even when infested by the European corn borer. The ear is carried fairly high on the stalk, cobs are medium in size, kernels bright yellow in color, tending to be smooth rather than deeply indented, vitreous rather than starchy and occasionally tending to be flinty. This hybrid stands up exceptionally well until maturity but may develop a moderate root weakness after the grain is ripe. It is superior to open-pollinated corn varieties of the same maturity in strength of stalk, leafiness, and yield. Its comparison with Duncan corn, a standard open-pollinated variety grown for many years in southern Michigan is given in Table 1.

Fig. 1. Michigan Hybrid No. 561.

Table 1. Comparison of Michigan Hybrid No. 561 with Duncan Corn in Monroe and St. Joseph county trials, 1935-38.

Variety	Number of Trials	Number of Years	Average Silage Yield Tons per Acre	Average Moisture Content of Grain at Harvest	Average Grain Yield Bushels per Acre Basis—14% Moisture
Michigan Hybrid No. 561	7	4	9.6	33.3%	62.7
Duncan	....	....	6.2	31.4%	54.5

Wisconsin Hybrid No. 645—This is a stiff-stalked yellow dent hybrid developed by the Wisconsin Agricultural Experiment Station and the parent stock used to produce seed certified in Michigan comes from this source. No. 645 is a little later than Wisconsin Hybrid No. 606 and apparently somewhat more productive for conditions under which it will mature.

Wisconsin Hybrid No. 606—This hybrid was developed by corn breeders of the Wisconsin Agricultural Experiment Station and seed is certified in Michigan under a cooperative arrangement with the Wisconsin Station which supplies all parent stock. According to our estimates, Wisconsin Hybrid No. 606 is about four days earlier in maturity than Michigan Hybrid No. 561. For grain production, it is adapted to southern Michigan and is somewhat less critical as to location than Michigan No. 561. It does not produce quite as large silage yields as No. 561 but may be used for silage in the same general territory.

Wisconsin Hybrid No. 606 is a very uniform hybrid with very stiff stalks which stand up well even after the grain is fully mature. The grain is golden yellow in color, moderately indented and of good quality. In our trials, this variety has not differed materially from Duncan corn in yield but its superiority in stalk growth and other physical characteristics warrant its use by growers who have had good success with Duncan corn. These yield comparisons cover three trials in two years but the comparative results are supported by those secured in a number of demonstrational trials conducted by R. E. Decker, Extension Specialist in Farm Crops, Michigan State College, working in cooperation with vocational agricultural instructors and students. The comparison of Wisconsin Hybrid No. 606 and Duncan corn is given in Table 2.

Table 2. Comparison of Wisconsin Hybrid No. 606 with Duncan Corn in Monroe and St. Joseph county trials, 1937-38.

Variety	Number of Trials	Number of Years	Average Silage Yield Tons per Acre	Average Moisture Content of Grain at Harvest	Average Grain Yield Bushels per Acre Basis—14% Moisture
Wisconsin Hybrid No. 606	3	2	8.2	37.8%	52.5
Duncan	....	....	7.3	36.0%	52.7

Michigan Hybrid No. 1218—This hybrid is made by top-crossing Pickett corn with Michigan Inbred No. 1459. Being a top-cross, it is not so uniform as most double-crossed hybrids but it has been a very satisfactory variety in central Michigan trials. It has matured grain satisfactorily as far north as Huron County and should be acceptable in more southern locations in the state which require an earlier variety than Michigan No. 561 or Wisconsin No. 606. Michigan Hybrid No.

Fig. 2. Michigan Hybrid No. 1218.

1218 has a stronger stalk than Pickett and other open-pollinated corn varieties but is not as outstanding in this respect as Wisconsin No. 606 and some other double-crossed hybrids. The ear is medium in size in keeping with its earlier maturity, the kernels are bright yellow, medium in indentation and of good quality.

Since Michigan Hybrid No. 1218 is adapted to the same general territory as Pickett corn, a comparison with that standard open-pollinated variety is given in Table 3.

Minnesota Hybrid No. 402—This early hybrid developed by the Minnesota Agricultural Experiment Station involves both white and yellow inbred lines so the hybrid crop is mixed in color. It has, thus far, given the best yields of any hybrid or open-pollinated variety in the northern trials, is as early as any hybrid tested and generally matures its grain satisfactorily in both Wexford and Otsego counties where the trials have been conducted. Northern corn growers have found it very satisfactory and earlier than the early strains of Golden Glow frequently used in that section. In Table 4, it is compared with Northwestern

Fig. 3. Minnesota Hybrid No. 402.

Table 3. Comparison of Michigan Hybrid No. 1218 with Pickett Corn in trials conducted in Ingham, Saginaw, Tuscola and Huron counties, 1935-38.

Variety	Number of Trials	Number o Years	Average Silage Yield Tons per Acre	Average Moisture Content of Grain at Harvest	Average Grain Yield Bushels per Acre Basis—14% Moisture
Michigan Hybrid No. 1218....	8	4	10.1	32.2%	65.4
Pickett....................	....	....	8.5	33.7%	55.4

Red Dent, one of the earliest open-pollinated dent corns. The parent stocks for Minnesota No. 402 seed certified in Michigan are annually brought in from Minnesota.

Table 4. Comparison of Minnesota Hybrid No. 402 with Northwestern Dent in trials conducted in Wexford and Otsego counties, 1935-38.

Variety	Number of Trials	Number of Years	Average Silage Yield Tons per Acre	Average Moisture Content of Grain at Harvest	Average Grain Yield Bushels per Acre Basis—14% Moisture
Minnesota Hybrid No. 402....	8	4	6.9	43.1%	38.4
Northwestern Red Dent......	....	....	6.5	42.4%	29.4

General Summary of Hybrid Corn Trials

The fact that Michigan Hybrids No. 561 and No. 1218, Wisconsin No. 606 and No. 645 and Minnesota No. 402 are the only hybrids which are now being certified by the Michigan Crop Improvement Association does not mean that these are the only hybrids adapted to certain sections of Michigan. However, corn growers who purchase out-of-state hybrid seed should take every precaution to make sure that the hybrid they buy is adapted to the location in which it is to be grown.

In Tables 5, 6, 7, and 8 are presented the comparison of several corn hybrids with a variety of known adaptation to a given locality. Because the actual yield in bushels to the acre is influenced so greatly by soil fertility and other environmental conditions, the comparisons in the following tables are expressed on a percentage basis.

Table 5. Grain yield of corn varieties which have been in three or more trials in southern Michigan, compared with that of Michigan No. 561 on a percentage basis.

Variety	Number of Trials in which Variety was Compared with Michigan Hybrid No. 561	Number of Years	Yield of Grain Expressed in Percentage of the Yield of Michigan Hybrid No. 561
Group No. 1—As early as, or somewhat earlier than, Michigan Hybrid No. 561.			
Michigan Hybrid No. 561	....	....	100%
Iowa Hybrid No. 931	4	4	98%
Kingscrost Hybrid F. B.	3	2	98%
Wisconsin Hybrid No. 606	3	2	90%
Duncan Yellow Dent	7	4	87%
Group No. 2—Later than Michigan Hybrid No. 561. Will require a very favorable season or other exceptional conditions to mature with safety in southern Michigan.			
Ohio Hybrid W-17	3	3	111%
Illinois Hybrid No. 368	3	3	110%
Iowa Hybrid No. 939	3	3	106%
Nebraska Hybrid No. 252	3	3	102%
Illinois Hybrid No. 366	5	4	90%

Table 6. Grain yields of corn varieties which have been in three or more trials in central Michigan, compared with that of Michigan Hybrid No. 1218, on a percentage basis.

Variety	Number of Trials in which Variety was Compared with Michigan Hybrid No. 1218	Number of Years	Yield of Grain Expressed in Percentage of the Yield of Michigan Hybrid No. 1218
Group No. 1—Of approximately the same adaptation as Michigan Hybrid No. 1218, or earlier.			
Michigan Hybrid No. 1218	....	....	100%
Minnesota Hybrid No. 402	3	3	95%
M. A. C. Yellow Dent	5	4	86%
Pickett Yellow Dent	5	4	85%
Golden Glow	4	4	76%
Group No. 2—Later in maturing than Michigan Hybrid No. 1218.			
Michigan Hybrid No. 561	4	3	100%
Wisconsin Hybrid No. 570	4	3	87%

Table 7. Grain yield of corn varieties, which have been in three or more official trials in the Michigan Thumb District, compared with Pickett Yellow Dent on a percentage basis.

Variety	Number of Trials in which Variety was Compared with Pickett	Number of Years	Yield of Grain Expressed in Percentage of the Yield of Pickett Yellow Dent
Group No. 1—Strains as early or earlier than Pickett.			
Michigan Hybrid No. 1218	3	3	115%
Pickett Yellow Dent	....	....	100%
Minnesota Hybrid No. 402	3	3	96%
Golden Glow Yellow Dent	4	4	86%
Group No. 2—Strains which, in these trials, appeared to be too late for this area.			
Wisconsin Hybrid No. 605	3	3	108%
Michigan Hybrid No. 561	3	3	96%
Duncan Yellow Dent	3	3	94%

Table 8. Grain yield of corn varieties, which have been in three or more official trials in northern Michigan, compared with that of Minnesota Hybrid No. 402 on a percentage basis.

Variety	Number of Trials in which Variety was Compared with Minnesota Hybrid No. 402	Number of Years	Yield of Grain Expressed in Percentage of the Yield of Minnesota Hybrid No. 402
Group No. 1—Of approximately the same adaptation as Minnesota Hybrid No. 402.			
Minnesota Hybrid No. 402	....	....	100%
Wisconsin Yellow Dent No. 25	6	3	95%
Kingscrost Hybrid E	6	3	94%
Northwestern Red Dent	8	4	77%
Group No. 2—Strains which, in these trials, appeared to be too late for this area.			
Michigan Hybrid No. 1218	3	2	94%
Minnesota Hybrid No. 401	5	4	94%
Kingscrost Hybrid E_1	4	2	88%
Wisconsin Hybrid No. 350	5	4	87%
Golden Glow	6	3	79%
Wisconsin Hybrid No. 450	6	3	75%
Wisconsin Hybrid No. 404	4	3	75%
Wisconsin Hybrid No. 455	4	3	73%
Wisconsin Hybrid No. 525	4	4	72%
Wisconsin Hybrid No. 550	4	2	69%

SUGGESTIONS FOR THE CONTROL OF SAWFLIES ON CONIFERS

E. I. McDANIEL
Section of Entomology

Sawflies infesting conifers have become increasingly destructive during the last decade, and field observations in 1938 indicate the present infestation will not decline naturally. Sawflies are particularly destructive to conifers, at times killing large numbers of trees on young plantations, nursery stock and trees in ornamental plantings. With this abnormal level in the sawfly population, it is apparent that a better understanding of the habits and life-history of the more important species should aid the grower in timing control measures to obtain the most satisfactory results.

Young sawfly larvae are gregarious. They usually feed in groups of a dozen or more. In many species this habit of feeding in colonies continues through the larval stage. At first the young larvae devour only the tender part of the foliage; later they consume the entire needle and may feed on the tender bark, girdling twigs and branches. From three to five weeks are required to complete their development. Certain species produce two broods each season, while others are limited to one. The spring brood usually restricts its feeding activities to the mature foliage while those of the second brood often consume the foliage of the current season's growth. The larvae are naked caterpillars with six true legs on the thorax and six or eight fleshy unsegmented prolegs on the abdomen. The caterpillars of sawflies are readily separated from the caterpillars of moths, since the fleshy prolegs of the sawfly larvae are not ornamented with the spine-like disk common to the larvae of moths.

Sawflies are so called because of the complicated egg-laying device of the female. This consists of several sharp-toothed, saw-like blades used by the insects to insert the eggs into the plant tissue. The adults are, for the most part, inconspicuous, thick-waisted wasp-like insects. They are seldom observed since they deposit their eggs and disappear long before the eggs hatch. Not all adults of a brood emerge the same season. In some cases a certain percentage of individuals will hold over until the following season before they emerge and deposit their eggs. This is an important item to consider when planning control measures—any effort to be productive should be followed for at least two consecutive years.

The following species of sawflies have been especially destructive in Michigan plantings during the season of 1938: The larch sawfly, *Lygaeonematus erichsonii*; Abbott's sawfly, *Neodiprion pinetum;* the red-headed sawfly, *Neodiprion lecontei*, and the imported sawfly, *Diprion simile*.

The larch sawfly, *Lygaeonematus erichsonii*, is practically restricted to larch. It is generally considered to be the most destructive of the

conifer sawflies, with its distribution limited only by that of its host plant. It is usually considered as a forest insect with a decided preference for mature trees, but young trees, nursery stock and trees on ornamental plantings are also attacked. The infestation usually develops first in the top of the trees. Not only do the trees suffer from defoliation by the larvae early in the season but the tender new growth is deformed and twisted by injuries resulting from the egg-laying punctures of the female.

There is one annual generation; the female appears after the new growth is several inches long and inserts her eggs into the tender green stems. Usually the eggs are inserted into the twig only on one side, which causes the twig to twist and curl. The larvae as they appear settle upon the previous season's growth. When present in sufficient numbers, they are capable of defoliating a tree. When mature, the larvae measure about two-thirds of an inch in length. The head and feet are black while the body is an all-over green of about the same tone as the under sides of the larch leaves. When disturbed, the larvae have the habit of assuming a "U" position, head and tail held rigid. This species is gregarious throughout its larval stages. The larvae complete their development late in June and after dropping to the ground, spin tough, papery cocoons in the soil and in duff under the trees, where they remain as larvae until the following spring, when they go into a resting stage. Then many individuals transform into wasp-like adult insects which emerge and place eggs for the current generation; others remain in the ground until the following spring before transforming into adults. Defoliated trees may put out new foliage and survive an outbreak provided other insect enemies, such as bark beetles and wood borers, do not kill the trees before they can regain their vitality. It is possible to control the larch sawfly with a properly timed application of a stomach poison or a contact spray. Usually the difficulty of getting the insecticide to the trees presents a problem.

Abbott's sawfly, *Neodiprion pinetum,* is the predominating species of sawfly attacking white pine in the southern third of the state. The larva is readily separated from *N. lecontei* by the fact that the head is always black. The larva is gray-green ornamented with regular rows of rectangular black spots. There are two broods of larvae each season, one in June-July, the second in August-September. Where an infestation is of old standing the broods overlap, and larvae in all stages of development may occur in a planting from June into October. Many larvae of the summer brood spin up in the foliage of the host tree, while those of the fall brood all drop to the ground and pupate under the soil. The eggs are inserted into the foliage.

The red-headed pine sawfly, *Neodiprion lecontei,* is common in the northern two-thirds of the state. It infests a wider range of host plants than *N. pinetum* and is correspondingly more destructive. It has been taken on Austrian pine, Scotch pine, red pine, jack pine and Mugho pine. During 1938 it was particularly destructive in red pine and jack pine plantings. The mature larva is whitish-yellow ornamented with rows of black dots. The head is red. There are two generations each year. The peak of the spring brood occurs in June-July, while the summer brood is most in evidence in September-October. Where the infestation is of long stand-

Fig. 1. Larvae of the red-headed pine sawfly.

ing, or of any great intensity, the broods overlap to such an extent that it is difficult to differentiate between them.

The imported pine sawfly, *Diprion similis,* is a European species which made its appearance in the United States some time previous to 1915. It has been recorded here and there throughout the northeastern United States, and in 1937 an infestation was discovered in a large planting of mixed conifers in the vicinity of Monroe, Mich. So far it has restricted its feeding to Scotch pine. There are two broods a year. The larvae of the summer brood mostly spin up on the foliage whole those of the summer brood enter the ground to form their cocoons. The adult sawfly lays her eggs in the needles.

Control

Since each infestation is an individual problem, several types of control are suggested. Without question, where a large acreage is involved, an arsenical spray is the most satisfactory. A spray with the following proportions has been found satisfactory:

3 pounds lead arsenate
1 quart summer oil
100 gallons of water

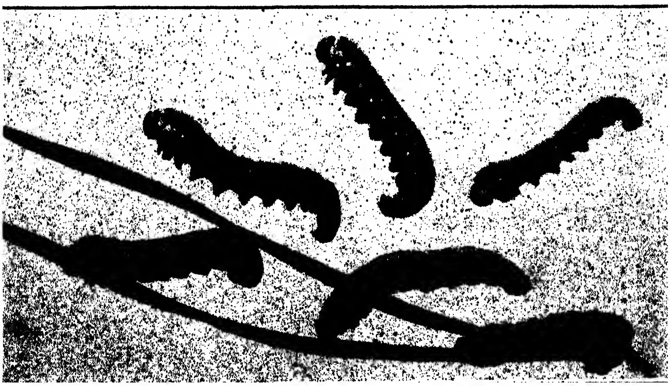


Fig. 2. Larvae of the imported pine sawfly.

For best results this spray should be applied with a power rig giving at least 200 to 300 pounds pressure.

On small plantings, or where the infestation is restricted to a few individual trees a dust applied with a hand duster is recommended. There are several small crank type dusters, costing around ten dollars, which have proved satisfactory. Of the dusts tested, three were found satisfactory; cryolite, calcium, arsenate and rotenone dust. Of these, both cryolite and calcium arsenate gave 100 per cent control.

*Cryolite was applied both undiluted and diluted with 3 parts talc as a carrier; no burning resulted and all larvae were killed, even those practically mature.

Calcium arsenate was diluted one part to ten parts hydrated lime. The control was equally good to that obtained with cryolite.

A rotenone dust containing .075 per cent rotenone killed a number of the larvae. It acted slowly, approximately 72 hours being necessary to obtain any indication of the kill. In all probability, this dust will be useful where an infestation occurs in the vicinity of vegetables or in outside living rooms.

It is possible to knock sawfly larvae from the trees and then to band trees with cotton, or sticky barriers, to prevent the larvae from re-establishing themselves upon the trees; in any event, take precautions to prevent their re-establishing themselves on their host-tree.

A NEW FUSARIUM-WILT-RESISTANT TOMATO

M. C. STRONG
SECTION OF BOTANY

A Fusarium-wilt-resistant strain of John Baer has been developed at the Michigan State College to fill the need of growers for a wilt-resistant, second early, market garden and canning tomato adapted to a short growing season. It is well known that tomatoes which are naturally self-fertilized, may be improved by isolating hereditary characters by selection. Whether John Baer may be regarded as a heterogeneous variety and the characters selected in this case were normally present in the variety, or whether they were the result of accidental crosses or mutations need not be discussed here.

Method of Development

The procedure followed was one of selection in soil artificially infested with 50 different isolates of *Fusarium lycopersici* which were obtained from various localities in Michigan as well as from Maryland, New Jersey, South Carolina, Tennessee, Wisconsin, Illinois, Indiana, Florida, Louisiana, Kansas, Missouri, Colorado, Arizona, California, Australia, and South Africa. Pure cultures of these isolates were grown

*The cryolite used contained sodium fluoaluminate 85 per cent and fluorine 45 per cent.

on sterilized oats in large containers at a temperature of 28° C. After about four weeks, when the fungus had grown over all the oats, the cultures were broken up and placed in large tubs where they were well mixed together. This composite mixture of cultures was the inoculum added to the seed bed soil and to compost used in transplanting seedlings to pots or flats. When the six-weeks old transplants were set in the field, a handful of the inoculum was placed beneath each plant in close proximity to the roots. Consequently many susceptible plants were eliminated in the seedling stage. Those that survived the field trial, since they had been subjected to three inoculations at different growth stages, were fairly certain to possess some degree of resistance, not merely to have escaped infection. The field trials were conducted on the same plot of ground year after year, and more inoculum was added to the soil each season.

Plants were examined for evidence of disease at several stages of growth. At the time of setting in the field, those already showing wilting, yellowing of leaves, and browning of vascular bundles were discarded. When fruit was beginning to ripen, the plants were again examined for visible symptoms of wilt. At the end of the season, all plants were cut across the base of the stem and examined for browning of the vascular bundles. Tissue plantings on culture media were made to determine the presence or absence of *Fusarium lycopersici*. The wilt fungus is often present in the vascular tissues of plants that show no external symptoms of disease. Seasonal infection records given here are based on the presence of this fungus in the vascular tissues, not merely on the criterion of external symptoms of wilt.

In making selections several points were kept in mind—plant type, fruit type, productiveness, and absence of the wilt fungus from the vascular tissues.

Origin and History

In the 1934 variety tests for resistance to Fusarium wilt, commercial John Baer (seed from Grand Rapids Growers Association) showed 65 per cent infection. From the surviving John Baer plants, the best individual was selected and seed was saved.

In 1935, the progeny of this plant was grown in wilt-infested soil as described above. This selection showed only 11 per cent wilt infection during the entire season as compared with commercial John Baer in which 74 per cent wilt developed. Five excellent plants showing no evidence of this disease were selected and seed was saved separately. Three of these selections were eliminated in green house trials during the winter, and in the spring of 1936 the other two (numbers 33 and 34) were planted in the wilt-infested field.

In 1936, the progeny of No. 33 (495 plants) were uniform large plants with a heavy set of rather flat-shaped fruit. The wilt infection was 27 per cent as compared to 62 per cent in commercial John Baer. The progeny of No. 34 (495 plants) showed only 7 per cent wilt infection and were uniformly tall, erect plants with large, oblate fruits. Number 34 was a more desirable tomato both from the standpoint of wilt resistance and fruit type. Three individual plants, (a), (b), and (c), were selected from this strain and seed was saved separately.

Green house trials eliminated selection No. 34a but the progenies of No. 34b and No. 34c were tested in the wilt-infested field in 1937,

and showed respectively 19 per cent and 23 per cent wilt infection as compared with 82 per cent in commercial John Baer. Both selections produced large, smooth, oblate fruits but No. 34c was seven to ten days later in maturing fruit than No. 34b and was discarded for this reason. Five individual plants were selected from No. 34b. Examination showed them to be free from the wilt fungus.

Progenies of these five selections were grown in 1938 in wilt-infested soil, as previously described. The plants were alike in appearance, in productiveness, and in yielding smooth, red, oblate fruits of uniform size. All five selections showed similar wilt resistance, ranging from 15 per cent to 19 per cent infection as compared with 62 per cent in commercial John Baer. It has been shown that selection in tomatoes will improve a variety by isolating hereditary characters, but once the strain has become uniform, futher selection will not intensify these characters. Since selection No. 34b produced uniform plants and fruits for two generations, it was concluded that further selection would be useless and therefore, the seed from the 1938 trials was combined.

The wilt infection percentages given above represent infection appearing after the plants were set in the field and do not include the number of plants already diseased which were discarded at that time. The percentage of wilt infection in the commercial John Baer variety would be greater if these discarded plants were included with the field record. However, this early infection is even more significant when considered from another standpoint.

The number of plants showing infection during the season is not the only consideration in determining the wilt resistance of tomato

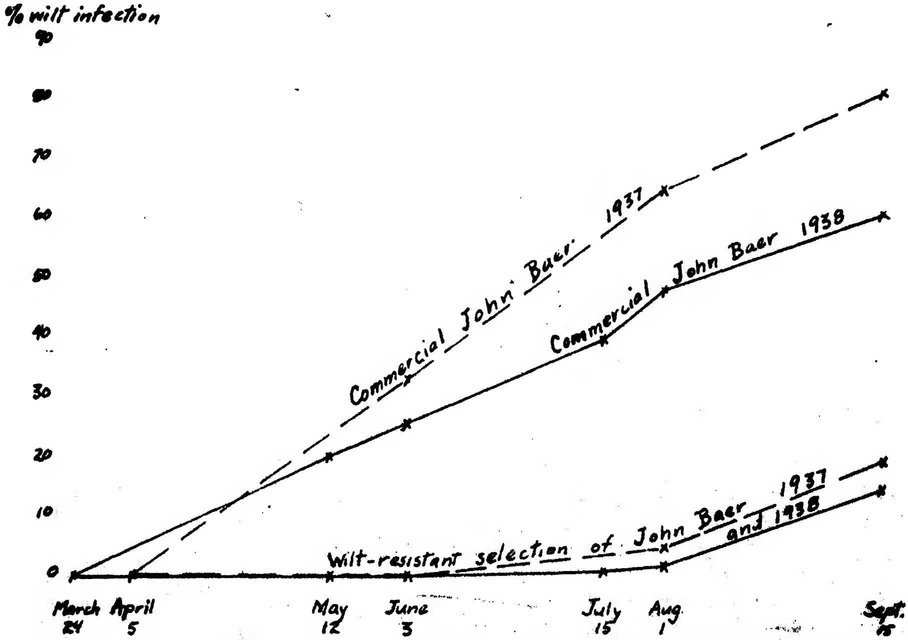


Fig. 1. Graph showing delayed infection in Fusarium wilt-resistant selection of John Baer as compared with the commercial variety.

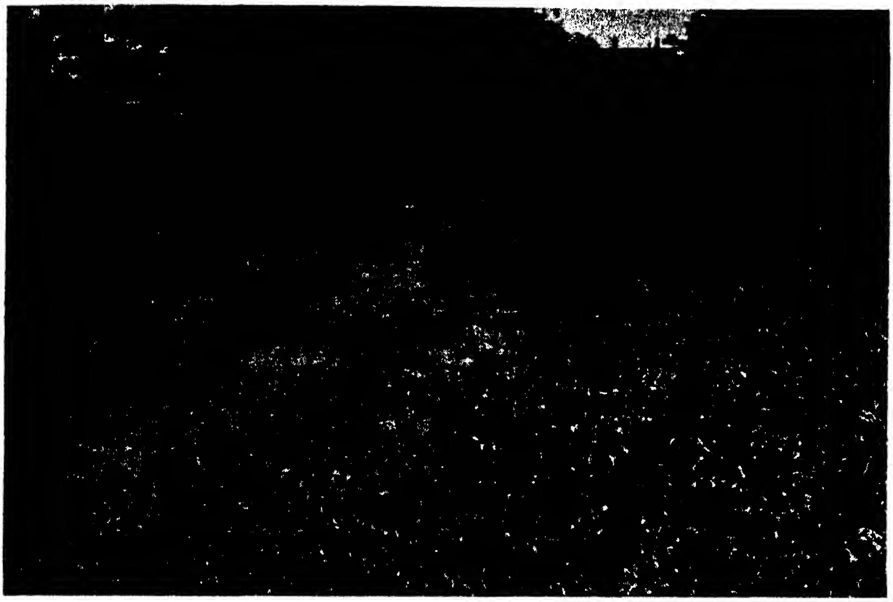


Fig. 2. Comparison between stands of Fusarium wilt-resistant selection and of commercial John Baer early in August. The two rows diagonally across the center of the picture are the commercial variety.

varieties. The time when infection occurs is also of importance. Plants becoming infected as late in the season as July or August will bear a crop of fruit before they succumb to the disease, while plants that are infected in May and June will have slight chance of producing mature fruit.

The graph in Fig. 1 illustrates the delayed infection of the wilt-resistant selection as compared with the commercial variety. On May 12, 1938, before time for setting in the field, 20 per cent of the commercial John Baer plants already showed severe wilt symptoms, while the wilt-resistant plants appeared perfectly healthy. The wilt-resistant selection showed no symptoms of the disease before the middle of July when fruit was beginning to ripen. At this time only 1 per cent infection was apparent in these plants as compared to 40 per cent in the commercial variety. The comparisons for 1937 present a similar picture. On June third, when the plants were set in the field, the wilt-resistant selection appeared healthy while the commercial John Baer plants showed 33 per cent wilt. By August first, 65 per cent infection was evident in the commercial variety as compared with 5 per cent in the wilt-resistant selection.

Characterization

The Fusarium-wilt-resistant selection of John Baer is in other respects, similar to the commercial variety, and may be characterized briefly as second early, requiring 63 to 73 days from transplanting medium-sized plants not yet in blossom to the first commercial harvest.

Plant medium-sized, semi-erect and spreading, foliage medium-dense, fruits moderately shaded. Ripe fruits deep oblate, 5½ to 6½ ounces. Cavity shallow, smooth, stylar end well rounded, scar small. Color grenadine to scarlet red. Walls medium, cells 6 to 7, regular. Radial cracks common, circular cracks rare.

Fig. 3. A first cluster of Fusarium wilt-resistant John Baer on the vine.

Adaptation

This strain should be adapted to all regions where John Baer is grown, and particularly where Fusarium wilt is prevalent. The resistance to Fusarium wilt is high, comparing favorably with such well known varieties as Marglobe and Pritchard. It is about one week earlier than Marglobe, and the quality of fruit is superior to Pritchard. Resistance and susceptibility to wilt infection are known to be considerably influenced by seasonal conditions of temperature and moisture. This tomato has been tested over a period of four years and has varied between 7 per cent and 19 per cent wilt infection. The trials

have been carried on in soils heavily infested with many different isolates of the causal fungus. While these isolates may not comprise all the possible existing strains of *Fusarium lycopersici*, their divergent geographical origin should insure a wide range of adaptability for this tomato.

On a fertile sandy loam soil, heavily wilt-infested, this wilt-resistant selection of John Baer yielded an average of 12.5 lbs. of fruit per plant, or approximately 20 tons per acre. Under the same conditions, commercial John Baer yielded 5 pounds of fruit per plant, or approximately 8 tons per acre.

Source of Seed

The Michigan Agricultural Experiment Station has no seed of this variety for sale. A number of commercial companies are being supplied with a limited quantity of seed for trial and for the purpose of increase. Distribution of the seed in this manner will enable commercial seedmen to supply demands for this variety.

VITAMIN A ACTIVITY OF MILK FAT*

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SECTION OF DAIRY HUSBANDRY

Among the many vitamins essential for optimal nutrition, vitamin A was one of the first to be discovered. Two groups of substances possess vitamin A activity in nature. One group, the true or colorless vitamin A such as found in liver oils, we might term the animal form. There are at least two members of this group, called A_1 and A_2. Thus far only the A_1 factor has been isolated in pure form. The other group known as the carotenes are reddish yellow pigments which are responsible for the yellow color of carrots and which we might term the plant form of vitamin A. There are four slightly different but closely related members which fall in this group. When an animal consumes these carotenes they are carried by the blood stream to the liver where they are changed to true vitamin A.

Milk fat contains both forms of vitamin A and in this discussion the combined biological effect of the two will be termed vitamin A activity.

When an animal receives insufficient vitamin A various symptoms appear. One of the first to occur is night blindness, a condition in which the animal can see properly in bright light but cannot see in dim light such as at dusk. Mild degrees of this condition probably exist in human beings more often than has been suspected in the past. In case of more serious deficiency loss of weight which is frequently accompanied by infections involving the eyes, salivary glands and lungs may occur. A deficiency of vitamin A is also associated with diarrhea, development of kidney stones, and degeneration of nerve tissue.

*From a portion of a thesis presented to the graduate school of Michigan State College as partial requirement for the Ph. D. degree.

The requirement of human beings for vitamin A has not been studied in sufficient detail to give exact figures. Estimates (1) of 1,400 to 2,000 units daily have been made for an adult as just enough to prevent the development of night blindness. This would be a minimal requirement while an estimate of 3,000 units has been made as ample for some storage of the factor in the liver. Estimates of 6,000 to 8,000 units have been made for growing children as sufficient to supply extra needs associated with growth, development and moderate body storage.

The chief sources of vitamin A for human beings are green leafy vegetables, peas, carrots, sweet potatoes, eggs, fish liver oils, milk, butter and cheese.

Many studies have been conducted at various experiment stations in this country and Europe on the vitamin A activity of milk fat as produced by the cow. The results show that the carotene content of the feed consumed is the most important factor. Thus milk produced on winter feed is much lower in its vitamin A activity than milk produced on green summer pasture. Dry pastures during the summer will cause some reduction compared to spring pasture because of lower carotene content. The feeding of roughages rich in carotene during the winter months will tend to promote the maintenance of the vitamin A activity of the milk fat at a summer level.

A significant observation (2) has been made in connection with the variation of the true vitamin A and carotene content of the milk fat of the different breeds. It has been found that with the same feeding conditions, the milk fat of the Holstein and Ayrshire has more of its vitamin A activity present as true vitamin A and less as carotene. In the case of the Guernsey or Jersey breeds the opposite is true. However, the total vitamin A activity of the different breeds per unit weight of fat is approximately the same.

In 1934 it was decided to study the vitamin A activity of milk fat as produced under Michigan conditions.

Experimental

Monthly milk fat samples were saved from a large supply of milk which came to the Michigan State College creamery from surrounding farms. The samples were therefore a composite of milk fat produced under the varying conditions existing on these farms. Monthly samples were also obtained from a Holstein cow (No. 174) of the Michigan State College dairy herd. This cow had calved in December 1934 and the first sample was taken a few days after calving, as soon as the milk was fit for use. This animal had been on pasture the previous summer and was receiving an ordinary winter ration of alfalfa hay, corn silage and grain. Milk fat samples were also obtained from a Holstein cow (No. A 14) in the Michigan State College experimental herd. She had always received alfalfa hay and a grain ration and had never been on pasture. Likewise with this cow, the first sample was obtained a few days after calving.

The vitamin A activity of these samples was determined by a biological method (3) using white rats.

In addition samples of milk fat were obtained from two groups of cows on winter feed before and after feeding silages put up by the

A. I. V.* methods.** One silage consisted of alfalfa and the other was a combination of oats and peas. Silage put up by this method is handled in the usual manner except that during the filling process, mineral acids are added as a means of preservation. This type of silage usually contains much more carotene than ordinary winter roughages. The vitamin A activity of these samples of milk fat was determined by a chemical method (4) and an attempt was made to place the results on the same basis as those obtained by the biological method of assay.

Results

The results obtained on the vitamin A activity of the milk fat samples shown in Tables 1, 2, and 3 have been expressed in terms of international units per quart of milk. The international unit is a biological unit adopted by the League of Nations committee on standards.

It will be noted in Table 1 showing the results with the samples obtained from the College creamery that when the herds were turned to pasture in May the vitamin A activity tripled and held up well until October when there was some decline.

Table 1. Effect of season on vitamin A activity of milk fat.

Date	International Units per Quart of 3.5% Milk		
	M. S. C. Creamery	Cow 174	Cow A-14
Dec. 1934	1,573	2,120	1,607
Jan. 1935	992	821	1,060
Feb. 1935	821	889	958
Mar. 1935	889	1,026	479*
Apr. 1935	718	1,334	513
May 1935	....	983**	....
May 1935	2,189	1,778***	513
June 1935	1,539	2,394	923
July 1935	1,607	2,667	1,778****
Aug. 1935	2,565	1,539	1,094
Sept. 1935	1,949	2,565	1,915
Oct. 1935	1,471	1,710	....
Nov. 1935	1,300	1,197	....

*Hay fed dropped from 30 to 20 lbs. per day.
**May 8 before pasture.
***May 28 after two weeks pasture.

The results with cow 174 from the College dairy herd showed much the same trend. The effect of pasture is well demonstrated by the two May samples. The second May sample was taken after the cow had been on pasture for two weeks and shows the quick response to pasture. It will also be noted that the first sample from this animal was high in vitamin A activity. This was the sample taken a few days after calving.

The results obtained with cow A 14 are similar to those of cow 174. It will be noted that owing to lowered hay consumption in March the vitamin A activity of the milk fat dropped considerably. It continued to

*"A. I. V." is designation of the acid treatment, named after the originator.
**Samples obtained from the Ira Wilson & Sons Dairy Farm at Fowlerville.

Table 2. Effect of feeding A. I. V. alfalfa silage on vitamin A activity of milk fat.

Days After Adding Silage	International Units per Quart of 3.5% Milk
0	616
7	804
15	1,129
20	1,180
27	1,464

be low until July when new 1935 hay was fed, which resulted in a considerable increase in the vitamin A activity of the milk fat.

The results in Table 2 show that the feeding of A. I. V. alfalfa silage produced a considerable increase in the vitamin A activity of the milk fed although not equal to that produced on summer pasture. Table 3 likewise shows that the feeding of A. I. V. oat and pea silage increased the vitamin A activity of the milk fat.

Table 3. Effect of feeding A. I. V. oat and pea silage on vitamin A activity of milk fat.

Days After Adding Silage	International Units per Quart of 3.5% Milk
0	513
7	1,129
14	1,505

Discussion of Results

The results show clearly that under Michigan conditions pasture produces a considerable increase in the vitamin A activity of milk fat. The reason for this is the high carotene content of green pasture grasses. Green pasture may contain from 200 to 300 parts per million of carotene on the dry basis, while alfalfa hay fed during the winter may contain only 15 to 50 parts per million. Alfalfa loses much of its carotene during the curing process and the loss continues during storage. This loss is greatest during the warm summer, fall, and spring months and least in the winter months.

When A. I. V. alfalfa or oat and pea silages were fed they also produced a considerable increase in the vitamin A activity of the milk fat. These results naturally raise the question of the preservation of roughages for winter feeding in order to produce milk of high nutritional value during this period. The A. I. V. method, while apparently efficient in the preservaton of carotene, is not used by the average dairy farmer to any great extent because of the need of chemical supervision during the filling process and special equipment for the application of the acids.

Studies are now in progress at several stations on the preservation of alfalfa or grasses with and without molasses. The results have been conflicting but after such factors as fineness of cutting, proper mois-

ture content, packing, stage of cutting and possibly others have been thoroughly investigated it may be possible to produce a silage rich in carotene by a more practical method.

The addition of phosphoric acid to green roughages for silage may offer a means of solution. However, to date figures on carotene preservation with this acid are not available.

The feeding of artificially dried hay offers another means of keeping up the vitamin A activity of milk fat during the winter months but involves a considerable investment for equipment and is expensive to operate.

The feeding of carrots has been advocated but is not very practical because of the labor involved in raising and handling the crop. It is also necessary to feed more than 10 pounds per day in order to obtain a worth while increase in the vitamin A activity of milk. It seems that a considerable amount of carotene must be added to a winter ration in order to obtain any measurable change in the milk fat. This is probably because the cow utilizes carotene inefficiently since estimates have shown that only 1 to 3 per cent is transferred to the milk as vitamin A activity.

The results show that under ordinary farm conditions summer milk has a much higher nutritional value than winter milk. It is to be regretted that butter produced while cows are on spring pasture is discriminated against on certain markets when it is actually more valuable from a nutritional point of view.

The vitamin A activity of milk fat is sufficient to be of considerable importance as a source of this factor in the human dietary. One quart per day is sufficient on the average to take care of the minimum vitamin A requirements for an adult according to the values previously given. The use of butter, cheese and ice cream would further increase this intake.

These results are in agreement with previously published data on the vitamin A activity of milk fat.

Summary

1. The vitamin A activity of milk fat varies with the season, being highest during the summer months and becoming increasingly low during the winter months.
2. This variation is due to a difference in carotene intake.
3. The feeding of feeds rich in carotene during the winter tends to increase the vitamin A activity of milk fat toward the summer level.
4. One quart of milk per day has sufficient vitamin A activity on the average to meet the estimated minimal vitamin A requirement of the adult.

References

1. Booher, L. A. Vitamin A Requirements and Practical Recommendations for Vitamin A Intake. Jour. Am. Med. Ass'n, **110**:1920 (1938).
2. Bauman, C. A., Steenbock, H., Beeson, W. M. and Rupel, I. W. Fat Soluble Vitamins. XXXIX. The Influence of Breed and Diet of Cows on the Carotene and Vitamin A Content of Butter. Jour. Biol. Chem. **105**:167 (1934).

3. Sherman, H. C. and Todhunter, E. N. The Determination of Vitamin A by a Method of Single Feeding. Jour. of Nutrition **8**:347 (1934).
4. Booth, R. G., Kon, S. K., Dann, W. J. and Moore, T. CLX. A Study of Seasonal Variation in Butterfat. I. Seasonal Variations in Carotene, Vitamin A and the Antimony Trichloride Reaction. Biochem. Jour. **27**:1189 (1933).

THE PONTIAC POTATO

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SECTION OF FARM CROPS

The Pontiac is one of the seedlings resulting from a Katahdin—Bliss Triumph cross made in 1930 by potato breeders of the United States Department of Agriculture. The seed from this cross was planted at the Potato Experiment Farm, Lake City, Mich. In 1931 the Pontiac was selected from several hundred of the resultant seedlings by members of the Farm Crops Department. This variety has been named Pontiac for the famous chief of the Ottawa Indian tribe which inhabited the Great Lakes region in Colonial times.

Since 1931 it has been grown in several localities in the lower peninsula as seedling number 401-23. In most instances the results have been satisfactory and the growers have been well pleased with its high yield, good quality and vigorous growth. For the last three years it has been grown in trial plots in Florida, Louisiana, Iowa, and North Dakota with encouraging results. The interest shown in this seedling by both Michigan and out-of-state growers warrants its introduction to Michigan farmers under a variety name, so that it can be more generally tested and its true worth be more quickly determined.

The Pontiac is a late maturing red potato, round to oblong in shape with medium deep eyes and crisp white flesh. The plant has large, dark green, rough-textured leaves and makes a vigorous upright growth. Comparing the Pontiac with its parents, the Katahdin and Bliss Triumph, the tubers closely resemble those of the Triumph in general shape and color, though in potatoes exceeding 8 ounces in weight the shape is more oblong than round. The Pontiac plant is much like the Triumph except that its growth is more vigorous. The leaves are flat and do not roll like those of the Katahdin. It sets four or more tubers per hill and resembles the Katahdin in its high percentage of number one potatoes. Its tubers are set close to the stem and deep. This deep setting habit appeals to growers who have had difficulty with the shallow setting of the Katahdin.

The Pontiac has not shown any marked resistance to insect and disease attacks; neither has it been much more susceptible than are standard varieties, such as Russet Rural, Green Mountain, Chippewa. Mosaic has been the major virus disease observed in Pontiac plots. Yellow dwarf has not developed in this variety to the extent that it has in Katahdin, Russet Rural, and Irish Cobbler. In some trials in Michigan and Iowa the Pontiac has proved more drouth-resistant than

***Table 1. Yields of potato varieties grown on college muck plots, East Lansing.**

Variety	Yield Per Acre Bushels							
	1936		1937		1938		Average	
	U. S. No. 1	Total yield	U. S. No. 1	Total yield	U. S. No. 1	Total yield	U. S. No. 1	Total yield
Pontiac	292.9	305.6	459.0	513.9	727.2	763.3	493.03	527.93
Russet Rural	193.7	238.2	164.3	294.0	501.0	543.0	286.33	358.40
Chippewa	194.7	220.0	337.2	406.4	784.0	875.3	438.63	500.56
Katahdin	348.1	357.3	380.4	415.0	583.4	632.6	437.30	468.30
Irish Cobbler	186.5	248.7	410.6	510.0	614.5	757.0	403.86	505.23

*Data furnished by Paul M. Harmer, Soils Department, M. S. C.

other varieties and has been freer from hollow heart and misshapen tubers.

In variety yield tests on the college muck plots at East Lansing the Pontiac has out-yielded other varieties except in 1936 when it was exceeded by Katahdin and in 1938 by Chippewa. The results of three years' tests are given in Table 1.

Several growers who have tried the Pontiac on muck soil report that it produces high yields with a high percentage of U. S. No. 1 potatoes, and that the tubers set deep and are free from sunburn injury.

The Pontiac also compares favorably with other varieties on upland soil. On sandy loam soils at East Lansing and Lake City in 1937 and 1938 it averaged slightly better than Russet Rural and Katahdin and practically the same as Chippewa in yields of U. S. No. 1 potatoes. It out-yielded Irish Cobbler 74 bushels per acre. Detailed results of this test are given in Table 2.

In 1938 approximately five acres of Pontiac potatoes were grown under the inspection service of the Michigan Crop Improvement Association, and a few hundred bushels of certified seed are available in small quantities to Michigan growers. Information concerning sources of seed may be obtained from the Farm Crops Department, Michigan State College, East Lansing.

Table 2. Yields of potato varieties grown on sandy loam soil at East Lansing and Lake City.

Variety	Yield Per Acre Bushels								Average	
	1937				1938					
	East Lansing		Lake City		East Lansing		Lake City			
	U. S. No. 1	Total	U. S. No. 1	Total	U. S. No. 1	Total	U. S. No. 1	Total	U. S. No. 1	Total
Pontiac	192	199	98	131	303	348	230	261	206	235
Russet Rural	144	193	93	140	291	320	241	287	192	236
Chippewa	203	223	111	128	267	320	248	275	207	236
Katahdin	149	160	97	135	260	270	274	294	195	215
Irish Cobbler	144	171	78	110	162	184	145	173	132	159

EARLY CUTTING AND FERTILIZATION OF QUACK GRASS MEADOWS

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In many parts of the Upper Peninsula of Michigan, most of the cleared land is occupied by grass meadows. Much of this grassland has lain undisturbed by the plow for several years. When seedings are made in this region, the stand of clover and other legumes is usually rather poor, and the resulting sod is usually predominantly grass. For a year or two, timothy may be a prominent part of the stand, but this very shortly gives way to a mixture of quack grass and bluegrass. These fields give a fair yield of grass hay, which may be harvested year after year with little outlay of labor or cash. The production of grain in this region is difficult and insufficient for the rations of the dairy cows that are kept there. Consequently, about $1,000,000 is spent annually for high-protein feeds in an attempt to balance the low-protein hay that is available locally.

In this region the amount of cleared land per farm is small, about 30 acres per farm. The power for preparation for seedbeds is inadequate, less than 1 horse per farm. Many of the farmers are or recently have been employed part-time in other industries and their experience has been only incidentally agricultural. Much of the land needs lime before legumes will make good growth. The surrounding lakes, cool nights, dewy mornings, and frequent rains make hay curing difficult. The hay is usually left standing until it is very ripe. In some regions, the maintenance of an acid soil has seemed necessary to avoid scab in the white-skinned potatoes produced.

This combination of circumstances has led to the perpetuation of agricultural conditions described. Despite past and present efforts of the agricultural experiment station and the extension service, the acreage of red clover, alfalfa and alsike clover remains small in this region. In isolated cases, excellent fields of alfalfa may be seen. These appear to have been established by the ordinary methods. Hard work, adequate power to prepare a clean, firm seedbed, a "sweet" soil, and perhaps fertilizer have been combined to give these productive hay fields. Such fields, however, are decidedly exceptional in most of this territory. Until a larger quantity of home-grown legume forage is available some provision must be made to provide extra protein for livestock rations.

With those facts in mind, a demonstration was arranged with the extension staff of the Upper Peninsula, providing for early and late cutting of quack grass meadows on plats with and without a high-nitrogen fertilizer. Previous work had shown that such early-cut hay was decidedly higher in crude protein than late-cut hay, particularly when fertilized. In each county of the Upper Peninsula, a suitable

quack grass meadow was selected, in which an area one and one-half acres in size was laid out. Two half-acre check plats were provided, one on each side of the fertilized area. In general, the fertilization consisted of ammonium sulphate broadcast at the rate of 200 pounds per acre, during the first week of May. Ammonium sulphate was used as a source of nitrogen because it is readily obtained in that region and cannot be confused with other fertilizers. Other forms of nitrogenous fertilizer have been used with comparable results. Since 10 or 12 such plats were laid out, fertilization and cutting dates varied slightly at different locations. In general, however, fertilization and cuttings were made in the southern counties first, so that the season was about comparable at the various plats.

The first cutting was taken from June 17 to June 25 in 1936 and in the corresponding week in 1937 and 1938. The later cutting was made the second week in July each year. In general, this later date was about the beginning of haying season in the Upper Peninsula. Across the two unfertilized areas and the fertilized plat three swaths were cut with the farmer's mower, to sample the area thoroughly. Measured lengths of these swaths were raked at once and weighed green. Samples were taken from the green hay of both the fertilized and the unfertilized areas, immediately after weighing. These samples were dried in an oven, with circulating hot air, at about 65° C. and weighed. The percentage of dry matter in the green hay was determined and the yield per acre thus computed. The dried samples were turned over to the Section of Agricultural Chemistry for analysis.

The accompanying table shows the average yield of hay, on a 15 per cent moisture basis, the percentage protein in this hay and the yield of protein per acre over the three-year period.

Table 1.

Early Cutting				Late Cutting			
	Hay (lb.)	Per cent protein	Pounds protein per acre		Hay (lb.)	Per cent protein	Pounds protein per acre
1936 Ck.	1,428	10.43	149	1936 Ck.	1,927	7.11	137
Fert.	2,688	11.05	297	Fert.	2,965	7.39	219
1937 Ck.	1,359	8.80	123	1937 Ck.	1,741	5.15	89.7
Fert.	2,707	9.72	246	Fert.	2,855	5.75	164.2
1938 Ck.	2,193	8.89	165	1938 Ck.	3,070	6.81	177
Fert.	3,612	10.38	318	Fert.	4,149	7.20	258
Av. Ck.	1,660	8.80	146	Av. Ck.	2,249	6.00	135
Fert.	3,144	9.13	287	Fert.	3,310	6.47	214

By examination of the table, certain comparisons may be brought out. Early cutting with fertilizer may be compared with the current practice, namely, late cutting without fertilizer. On this basis, it may be noted that in 1936, the yield of protein was increased from 137 to 297 pounds per acre; in 1937, from 89.7 to 246; in 1938, from 177 to

318 pounds protein per acre. Nineteen thirty-six was a dry year, 1937, a very dry year, and 1938 a rather wet year. The yield of hay per acre, comparing early-fertilized with late-unfertilized, was in 1936—1,927 pounds to 2,688; in 1937, 1,741 pounds to 2,707; in 1938, 2,249 pounds to 3,144. By fertilizing, and cutting early, the yield of protein was doubled, and the yield of hay increased by about half a ton per acre. The quality of the hay was improved greatly. The percentage of protein in the late-cut hay was 6.00, while in the early-cut, fertilized hay it was 9.13.

Whether fertilized or not, late cutting resulted in a loss of protein yield per acre. Relatively little increase in yield was obtained by permitting fertilized hay to stand until late cutting, while the quality decreased markedly.

The annual cost for fertilizer in this program was approximately $4 per acre and, as a three-year average, resulted in an additional yield of 152 pounds of protein per acre. Better hay was produced, it was lower in fiber and higher in digestible nutrients than late-cut hay from unfertilized fields; and there was about a half ton more hay per acre. During the three years of the demonstration, early-cut hay seemed to be as easy to cure as was hay cut late. In those years most of the rain fell during the later period, although during several years there is little difference, according to weather records. Results to be obtained in ordinary cutting practice with various fertilizers, have been shown by Tyson in Mich. Quarterly Bul. Vol. 19, No. 1, p. 1-8, Aug. 1936. Other fertilizers, high in nitrogen but containing other fertilizer elements for soils deficient in them, may be more economical than ammonium sulphate and better adapted to the "sour" soils of the region. In view of the results of the demonstration, it is likely that early cutting and fertilization with ammonium sulphate is a profitable practice under the agricultural conditions described, where high-nitrogen concentrates are purchased in any case, and where legume forages are scarce for winter feeding.

If one were to compare the expense over a three-year period for ammonium sulphate in fertilizing a five-acre field of quack grass (about $60) with the expense of liming and seeding to alfalfa, with the work involved in eradicating the quack grass and preparing a clean, firm seedbed, the problem takes on a slightly different aspect. It would be far more work to put in the alfalfa than to apply the ammonium sulphate. The cash outlay for the ammonium sulphate perhaps would exceed somewhat the expense for lime and seed and fertilizer for the alfalfa. The yield of hay from the alfalfa should, in one cutting, equal the yield of fertilized quack grass in one cutting. If it did, the yield of protein from the alfalfa should be almost double the protein yield from the quack grass. The soil, following the alfalfa, should be somewhat sweeter than it was before liming; and following the quack grass, somewhat "sourer" than before applying ammonium sulphate. According to feeding experiments at Michigan, Cornell, and Wisconsin, the early-cut grass hay seems to be as good a feed for dairy cows as alfalfa hay when the protein contents of the two rations are balanced by protein supplements. The expense for the ammonium sulphate is spread over three years, while for alfalfa it is concentrated in one year. The alfalfa hay is the more difficult to cure. Far more traction power

and far more agricultural skill is required to establish the alfalfa meadow. For those farmers who must avoid a "sweeter" soil, or who cannot make arrangements for suitable power and machinery to prepare a clean, firm seedbed, or who lack the skill to prepare a good seedbed, early cutting of fertilized grass meadows seems a desirable practice.

On the other hand, for those who seek a more stable means of maintaining the productivity of their fields and a forage that is of recognized superiority in livestock rations, more promise is afforded by the culture of alfalfa or suitable mixtures of alfalfa with other adapted legumes and grasses.

HOME-GROWN FARM PRODUCE USED BY THE FARM HOUSEHOLD

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The value of produce grown on the home farm and used by the household is an item worthy of much attention on the average Michigan farm. This is especially true on the self-sufficing farms and on the many small farms throughout the state where the home-grown produce makes up a large percentage of the actual farm income.

Records of the amounts and values of home-grown produce used by the farm family were kept in 1937 by 255 of the 1,333 farmers cooperating with the Farm Management Department in the extension project in farm accounting. Many others kept a partial record of the produce used in the home, but only complete records are included in this report. It is only logical that the amounts and prices of farm produce used in the farm household should vary in different parts of the state because of different types of farming, different types of and distances to markets, and different food consuming habits. With this in mind, the 255 farms used in this study were distributed into three groups: (1) Southern Michigan—156 farms in counties south of a line drawn between the southern boundaries of Mason and Arenac counties; (2) Northern Michigan—70 farms in the remaining northern counties of Lower Michigan; and (3) Upper Peninsula—29 farms.

The average value of the home-grown farm produce used in each household in 1937 for all 255 farms used in this study was $306.13. Similar studies were made in 1935 and in 1936, and the average values reported were slightly lower, $287.28 and $292.39, respectively. The farmers keeping the records in these studies were instructed to use farm prices to determine the value of the farm products used in the home and it was estimated that the city retail prices would be about double farm prices which would make an average of about $600 a farm. It would be incorrect, however, to use retail prices in these calculations for they include charges for transportation, commission, processing, wholesaling, and other items not logically included in farm prices. It should also be mentioned that "farm prices" are not the same on all farms even in the same section of the state because each

farmer determines his own price for each of his home-grown home-used products.

The average value of home-grown farm produce used in 1937 in each of the 156 farm households in the southern counties was $289.60. The average size of family on the 131 farms furnishing this information was 3.6 persons over 12 years of age and 1.13 children. The lowest value of products used per family was $63 for a family of 2 adults and 1 child, and the highest was $663 for a family of 5 adults.

The amounts and values of farm products used by the farm household on the 156 southern Michigan farms during 1937 are shown in Table 1. This table shows the average amounts for all families included in the report and also for just the families that used the particular item. For example, the 156 farmers used an average of 18 cords of wood valued at $32.96, but the fact that only 123 of the 156 actually used wood from their farms raised the average to 23 cords valued at $41.80 a farm. Only 75 reported the use of home-grown beef and the value was $30.19 a farm. It should be mentioned that because of a lack of comparable quantity units on several items only average values have been shown.

Table 1. The amounts and values (at farm prices) of farm products used by farm households on 156 southern Michigan farms during 1937. Average size of family, 3.6 persons over 12 years of age and 1.13 children.*

Item	Average per Farm for the 156 Farms			Average for Farms Using		
	Amount	Price	Value	Number of farms	Amount	Value
Fuel, cords	18	$1.81	$32.96	123	23	$41.80
Milk, quarts	1,273	.044	55.63	156	1,273	55.63
Cream, pints	71	.15	10.39	81	137	20.00
Butter, pounds	66	.34	22.83	80	129	44.52
Eggs, dozen	132	.22	28.69	146	141	30.66
Poultry	—	—	17.60	133	—	20.65
Beef, pounds	136	.11	14.51	75	282	30.19
Pork, pounds	255	.11	27.40	105	378	40.71
Mutton, pounds	6	.10	.63	12	86	8.17
Potatoes, bushels	29	.67	19.35	152	30	19.86
Other vegetables	—	—	19.58	133	—	22.96
Fruit	—	—	12.97	116	—	17.44
Products canned	—	—	24.94	109	—	35.69
Miscellaneous	—	—	2.12	24	—	13.75
Average per farm			$289.60			
House rent (10% of value)			213.38			

*Average size of family based upon 131 farms furnishing this information.

Table 2 shows that the farmers in the northern part of the state used larger amounts and values of home-grown products in the farm household than did those in the southern counties. The average value of products for the 70 farms was $331.63 as compared with $289.60 in the southern area. The average size of family on the 62 farms furnishing this information was 4.0 persons over 12 years of age and 1.29 children. The lowest value of produce used per family was $86 with a family of 3 adults and 1 child less than 12 years of age and the highest was $769 with a family of 8 adults.

Table 2. The amounts and values (at farm prices) of farm products used by farm households on 70 northern Michigan farms during 1937. Average size of family, 4 persons over 12 years of age and 1.29 children.*

Item	Average per Farm for the 70 Farms			Average for Farms Using		
	Amount	Price	Value	Number of farms	Amount	Value
Fuel, cords	32	$1.54	$49.47	53	42	$65.34
Milk, quarts	1,057	.043	45.19	70	1,057	45.19
Cream, pints	148	.14	21.17	58	178	25.55
Butter, pounds	147	.34	50.34	62	165	56.84
Eggs, dozen	113	.22	24.53	63	126	27.25
Poultry	—	—	15.37	61	—	17.64
Beef, pounds	126	.10	12.92	35	253	25.83
Pork, pounds	307	.10	32.01	56	384	40.02
Mutton, pounds	15	.09	1.44	8	133	12.62
Potatoes, bushels	36	.49	17.82	69	37	18.07
Other vegetables	—	—	15.90	58	—	19.19
Fruit	—	—	15.16	56	—	18.95
Products canned	—	—	27.27	54	—	35.35
Miscellaneous	—	—	3.04	14	—	15.21
Average per farm	....	....	$331.63			
House rent (10% of value)	....	....	139.63			

*Average size of family based upon 62 farms furnishing this information.

Table 2 also shows the amounts and values on the basis of all farms included in the study and also on the basis of the farms using the particular product. As would be expected, the farmers in the northern counties used much more fuel from their farms than did those in the southern part of the state. It should also be noted that the farmers in this area used much more of the cream and butter produced on their farms than did those in the southern counties. This was probably

Table 3. The amounts and values (at farm prices) of farm products used by the farm households on 29 Upper Peninsula Michigan farms during 1937.

Item	Average per Farm for the 29 Farms			Average for Farms Using		
	Amount	Price	Value	Number of farms	Amount	Value
Fuel, cords	31	$1.64	$51.41	24	38	$62.12
Milk, quarts	1,487	.041	60.59	29	1,487	60.59
Cream, pints	180	.13	23.34	19	274	35.63
Butter, pounds	107	.33	35.55	20	155	51.55
Eggs, dozen	107	.23	24.86	27	115	26.70
Poultry	—	—	12.21	21	—	16.86
Beef, pounds	143	.11	15.00	17	243	25.59
Pork, pounds	270	.13	35.17	20	391	51.00
Mutton, pounds	—	—	.48	2	—	7.00
Potatoes, bushels	32	.65	20.41	28	33	21.14
Other vegetables	—	—	18.90	24	—	22.83
Fruit	—	—	10.04	21	—	13.86
Products canned	—	—	24.14	23	—	30.43
Miscellaneous	—	—	1.45	3	—	14.00
Average per farm	....	....	$333.55			
House rent (10% of value)	....	....	157.19			

because in the northern part of the state the farms are of a more self-sufficing type and a much smaller percentage of the dairy production is removed from the farms as whole milk.

Only 29 complete records were available from the Upper Peninsula, so the statistics presented in Table 3 are less representative of this portion of the state than might be desired. The figures are significant, however, in that they may be compared with those for other sections of the state.

The average value of products used per farm was $333.55 for the 29 farms, which was slightly more than the similar figure for the northern counties of lower Michigan and about $34 more per farm than for the southern counties. The lowest value per farm was $177 for a family of 3 adults and 3 children and the highest was $693 for a family of 8 adults and 2 children. Most of the values, however, were between $200 and $400 per farm. All of the farms provided the household with milk and all but two provided eggs while only two provided home-produced mutton.

Another important item on the farm that has not been discussed is the value of the use of the farm dwelling. In the farm account book the farm dwelling is not included as a part of the farm business and, therefore, the interest, repairs, and depreciation on it are not included in the expense items. The average dwelling on the 255 farms was valued at about $1,880 and if a fair annual rental is assumed to be about 10 per cent of the value, it would be equivalent to about $188 per farm.

Economic conditions during the last few years have brought about increased interest on the part of many people in the amount of home-grown produce used by farmers' families. As well as giving total figures for the 255 farms studied for 1937, Table 4 makes it possible to compare data showing the amounts of the various products used for several recent years. It must be borne in mind that prices change from year to year and the values are, therefore, not too significant when different years are compared but they are the best available in this brief study. Significant observations from this table show that the consumption of home-produced meat has recently increased, home-produced butter and eggs have decreased slightly, and the inventory value of farm dwellings has fallen. Despite popular opinion, however, it does not appear from this table that the depression brought about a marked increase in the use of home-produced farm products.

Much of the home-grown portion of the family's food supply is produced in connection with the regular commercial crop production. In some parts of the state and on many farms, however, some of the crops are not produced on a commercial basis and, when grown at all, are grown only for home consumption. Illustrations of such products are hogs, poultry and eggs, fruit, potatoes, and dairy products. The adaptability of farmers' abilities to their resources usually determines what may best be grown on a commercial basis in different parts of the state. Commercial production of all the usual home-used products discussed in this report is not recommended for all parts of Michigan, but most of these products may be justifiably produced on a limited basis for home consumption. In most instances, a farmer will find it advantageous to produce a large proportion of the produce used by his family.

Table 4. The average amount of farm products used annually by farm households on some account keeping farms in Michigan, for seven recent years[1]

Item	1929	1930	1931	1933	1935	1936	1937	7-year average[4]
Number of records	51	97	284	278	163	239	255	195
Fuel, cords	20	18	25	27	28	24	24	24
Milk, quarts	1,204	1,112	1,241	1,199	1,263	1,244	1,239	1,215
Cream, pints	114	123	87	113	88	92	105	103
Butter, pounds	123	94	103	99	99	96	93	101
Eggs, dozen	137	142	137	131	116	122	124	130
Poultry	$18.70	$17.42	$13.06	$11.37	$16.18	$15.06	$16.38	$15.45
Beef, pounds	79	82	101	155	140	133	134	118
Pork, pounds	272	211	228	320	293	303	269	271
Mutton, pounds	—	25	12	10	10	—	9	9
Honey, pounds	17	11	6	—	—	—	—	11
Potatoes, bushels	37	27	32	30	34	30	31	32
Other vegetables	$19.61	$19.38	$16.51	$15.13	$16.37	$14.89	$18.49	$17.20
Fruit	22.12	16.12	30.80[2]	11.02	15.02	11.84	13.24	17.17
Products canned	—	—	—	16.87	21.86	16.33	25.49	20.14
Miscellaneous	11.31	14.65[3]	1.83	3.61	4.98	2.79	2.29	5.92
Total value of products used	$372.47	$310.43	$264.02	$233.53	$287.28	$292.39	$306.13	$295.18
House rent (10% of value)	203.51	222.29	216.88	204.78	179.60	185.85	187.93	200.12

[1]Farm prices were used for each particular year.
[2]Includes both fresh and canned fruit.
[3]Includes canned fruit.
[4]Each year given equal weight.

A PRACTICABLE METHOD OF TOP-WORKING LARGE APPLE TREES

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Top-working large apple trees has generally seemed impracticable, even when the trees are sound and vigorous, for two reasons.

The immediate difficulty inheres in the large number of branches which must be grafted, if the operation is restricted to stubs of two inch maximum.

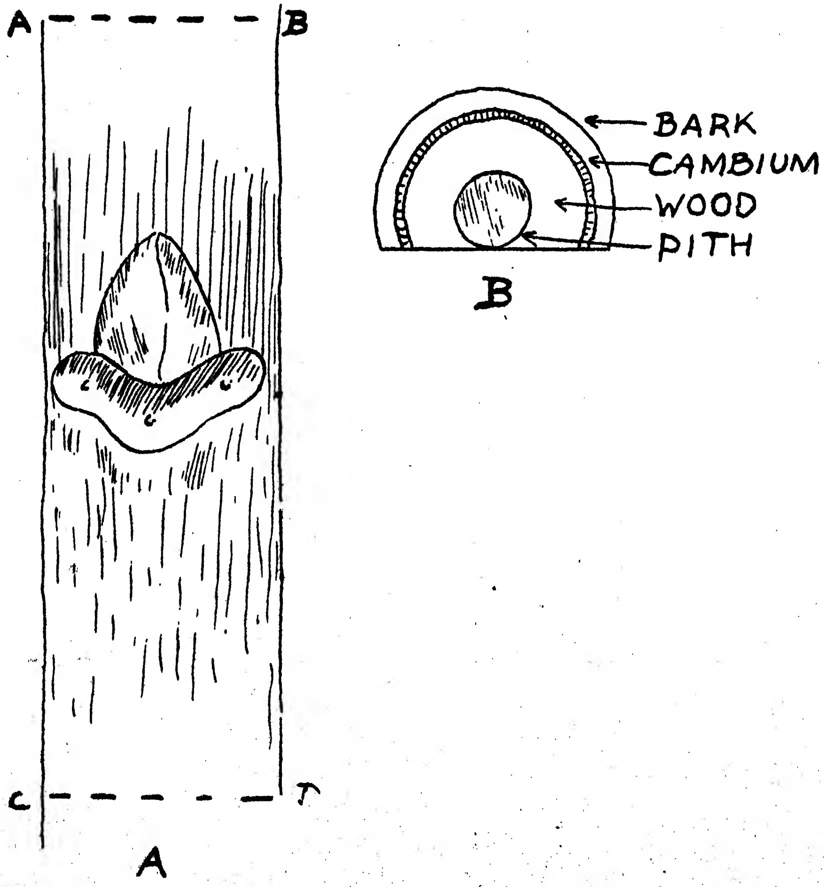

Fig. 1. Method of preparing scions. In A, the lines A-B and C-D mark the points where the scion is cut, though the scion is usually at least an inch long and may be two or more inches long and possess several buds. B shows a cross section of the prepared scion.

Fig. 2. Several scions that are starting their second year's growth. Note the slits that have been cut in the bark at the side of each scion to permit expansion from pulling the bark away from the edges of the scion.

Observations on numerous occasions and trials in the College Orchard at East Lansing have not warranted recommendation of grafting stubs larger than those of two inch diameter. Scions will grow, if set by the bark grafting method, on stubs of any size, but on large stubs they are subject to breakage by wind, and healing over is too slow to insure sound unions. Consequently, grafting large stubs in order to reduce the amount of labor involved in top-working a tree is not advisable.

Another objection to top-working large trees by the usual method lies in the fact that when the new scions begin bearing, the fruiting

area is restricted to a high outside zone, and that all shoots arising below the graft unions must be suppressed. Thus the renewal of fruiting wood is restricted.

Scrutiny of most fairly mature apple trees will reveal that most of the present crops in the best areas of the tree are borne on comparatively new wood which has grown up through the drooping older branches as the latter were pulled down by weight of fruit, never returning to their former positions. This suggests the feasibility of grafting watersprouts, thinning the top of the tree, and removing more and more of the older limbs, thus letting these grafts grow on through to the outside. Experience has demonstrated that this method is entirely practicable and that if it is followed, the total amount of grafting involved can be materially reduced and the renewal effected at a lower level.

Fig. 3. A tree topworked by the modified inlay method after a year's growth of the scions.

Fig. 4. A scion that has been set on a vertically growing limb. Note the sharp-angled crotch, an objectionable feature.

Unfortunately, watersprouts are not always available, particularly at points which would be most desirable for utilization in top-working. Furthermore, many watersprouts originate in a manner that makes them easily broken at the point of attachment.

That branches can be produced at will on most portions of scaffold limbs has been demonstrated by trials running over several years in the College Orchard at East Lansing. The operation involved resembles, superficially, patch-budding, but is probably to be considered grafting, since the technique resembles that employed in setting an inlay graft, such as often used in approach-grafting or bridge-grafting across an injury. As a matter of fact, if a bridge graft were set by the inlay method and the portion of the bridge cut away leaving only the two end pieces attached to the bark, we would have a true picture of the method herein described. It is very simple in execution and is not time-consuming.

This grafting is best done when the bark begins to slip freely (usually in May). The best scions are dormant one-year wood of the type ordinarily used in grafting; large scions are preferable, but those of ordinary size may be used. Scions are cut at points indicated by the lines A-B and C-D shown as A in Fig. 1. These scion portions may be two to six inches in length and may include one or more buds. The segment thus obtained is shaved on the side opposite the bud until the pith is barely exposed; it is practically split in half as shown in cross section as B, Fig. 1.

At the point where the graft is to be inlaid, the outer corky part of the thick bark is sliced off with a knife, leaving the "fleshy" cortical portion of the bark. On this the prepared scion is laid parallel to the

Fig. 5. A scion that was set on a horizontal limb. Note the right angle that it has made with the limb, providing an element of mechanical strength.

Fig. 6. An old tree completely topworked to Steele. All the old variety stock limbs have been removed and most of the fruiting wood has originated from scions set by the modified inlay method. About eight large watersprouts were cleft grafted to round out the job. (Photographed April 1938.)

grain of the branch and its outline marked in the bark by tracing around the scion with a knife point. Remove the scion and with the knife retrace its course, cutting down to the wood; the piece of bark is then removed and the scion inserted, with its cut face against the surface of the exposed wood. The scion is pressed and held against the surface of the wood with two small wire nails. Parallel to the scion and about two inches from it a cut is made in the bark on either side extending an inch or two beyond each end of the scion. This is to keep the expansive growth force from pulling the bark away from the edge of the scion. The entire scion is coated with grafting wax, including the cut edges of the bark surrounding the scion, but not over the parallel relief cuts to the side of the scion. Nothing further is needed.

With very little practice, an agile worker can set 25 of these inlay grafts well scattered over the scaffold limbs in an hour. Most of

them will grow the first year, but some may lie dormant a year. The total "take" of these scions, in a vigorous tree, with some of the outer branches removed, averages as high or higher than that obtained from ordinary grafting.

These scions should be placed where they can be used most advantageously in developing a new top. They should not be set on vertical or nearly vertical limbs or portions of limbs, because in such positions the growth from them often forms a narrow angled crotch (Fig. 4). They should not be placed on the exact top of diagonal or horizontal branches, because in older trees the callous formation requisite to union is slow at this point. A few degrees to the side of this top line seems to be the best location, considering both the immediate success of the grafting and the ultimate growth of the new branches.

Fig. 7. A close view of the test tree, showing some of the new limbs induced by placing modified inlay grafts. The slit on either side of these limbs is the healed-over tension release slit cut on either side of each scion as described in the text. The best of these may now be saved for permanent limbs.

It is probable that in most cases a small amount of cleft grafting at the tip of each scaffold limb will be desirable to avoid leaving a stub. Desirable watersprouts should be cleft-grafted. In short, the inlay grafts should be placed where no suitable limbs remain and where new limbs are desired. The laterals, however, can be removed gradually, and replaced by the growths from the new grafts. Thus with a total expenditure of much less labor than is involved in the usual cleft grafting and with much less interruption of cropping, a rather large tree can be worked over into a tree more easily handled in later years than the one grafted high. The point should be emphasized, however, that a tree that is not vigorous is hard to top-work satisfactorily by any method.

It should be stated that limbs produced in this manner are still comparatively young, and some doubt may be raised as to whether they will tear out under the combined stress of crop, rain, sleet and wind. Present indications are that the limbs will be satisfactory, unless they are forced to inordinately rapid growth. Watersprouts which develop into fruiting branches usually are well enough anchored to withstand usual stresses, and branches from this type of graft have an anchorage in the parent more extensive than that of most watersprouts.

A final precaution should be mentioned. In renewing an old tree by any method, sun-scald is its worst enemy. If sufficient growth is not present to protect all bark on the top of main limbs, a whitewash of cold water paint should be applied to the most important scaffold branches soon after the grafting is done.

THE CRAB APPLE, COMMERCIALLY CONSIDERED

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The crab apple has been well known since the early days of Michigan's fruit industry. However, little information is available on its economic status. Some fruit growers believe that crab apple orchards are unprofitable and should be replaced by other crops. The commercial canners report that the production of crab apple jelly and preserves is declining. Though of limited interest compared with other fruits, the crab apple is grown on many farms and is a source of considerable income and this report on the marketing and production of crab apples in one fairly representative producing area is likely to be of interest to many individuals.

Method of Making Study

This study was made in Allegan County through the cooperation of the Fennville Fruit Exchange, the principal fruit marketing agency for the fruit growers of that area. Most of the data were obtained from the records of the Exchange which showed for each individual grower: (a) the grading record for each kind of fruit, (b) the washing, grading, package and packing costs, and (c) the prices for which the fruit was sold and the amounts returned to the grower for each grade.

These individual grower's records were assembled and summarized to show the total income from all fruits sold through the Exchange during 1931 to 1933, inclusive, and for the principal crab apple growers for 1934, 1935 and 1936. The gross returns obtained from the sale of apples, pears, crab apples, cherries, grapes, plums and quince for the same years were then determined. These returns were then figured in terms of percentage to show the relative importance of each fruit as a source of income. (See Table 1).

The records and the orchards of the principal crab apple growers, those whose production averaged 125 or more bushels of crab apples per year, were then selected for a more intensive study. Each grower

Table 1. Part A. Fruit Exchange's gross incomes from different fruits for the years 1931-1933.

Kind of Fruit	Year	Gross Income	Percentage
Apples	1931	$40,014.06	36.9
Pears	1931	26,635.53	24.5
Peaches	1931	15,708.99	14.5
Crab Apples	1931	5,350.30	4.9
Cherries	1931	15,606.77	14.4
Grapes	1931	1,786.45	1.6
Plums	1931	3,025.46	2.7
Quince	1931	203.80	.1
		$108,331.36	
Apples	1932	$59,501.31	46.0
Pears	1932	31,028.03	23.9
Peaches	1932	24,288.19	18.7
Crab Apples	1932	5,124.20	3.9
Cherries	1932	1,543.90	1.1
Grapes	1932	1,397.54	1.0
Plums	1932	6,260.00	4.8
Quince	1932	140.75	.1
		$129,263.92	
Apples	1933	$48,094.77	52.3
Pears	1933	22,727.07	24.7
Crab Apples	1933	4,100.30	4.4
Peaches	1933	1,882.25	2.0
Cherries	1933	5,586.15	6.0
Grapes	1933	1,000.25	1.0
Plums	1933	8,522.32	9.2
Quince	1933	8.25	.0
		$91,921.36	

The principal crab apple growers' share of the Exchange's gross income—$35,148.09 or 32.4 per cent in 1931, $52,096.23 or 40.2 per cent in 1932 and $34,303.68 or 37.3 per cent in 1933.

The percentage of gross income of the Exchange from crab apples contributed by the principal crab apple growers—$3,132.10 or 58.5 per cent in 1931, $2,655.38 or 51.8 per cent in 1932 and $2,992.00 or 72.9 per cent in 1933.

Table 1. Part B. Gross incomes from different fruits of the principal crab apple growers of the Exchange for the years 1934-1936.

Kind of Fruit	Year	Gross Income	Percentage
Apples	1934	$45,685.23	63.6
Pears	1934	17,598.97	24.5
Crab Apples	1934	3,450.50	4.8
Cherries	1934	1,916.40	2.6
Grapes	1934	638.05	.8
Plums	1934	2,476.35	3.4
Quince	1934	3.50	.01
		$71,769.00	
Apples	1935	$13,354.83	29.9
Pears	1935	20,983.18	46.3
Peaches	1935	4,911.07	10.8
Crab Apples	1935	3,408.50	7.5
Cherries	1935	1,163.87	2.5
Grapes	1935	No Data	
Plums	1935	1,484.94	3.2
Quince	1935	4.80	.0
		$45,314.79	
Apples	1936	$39,932.16	57.9
Pears	1936	16,478.65	23.9
Peaches	1936	2,667.80	3.8
Crab Apples	1936	5,617.30	8.1
Cherries	1936	2,020.52	2.9
Grapes	1936	186.00	.2
Plums	1936	2,001.62	2.9
Quince	1936	4.85	.07
		$68,908.90	

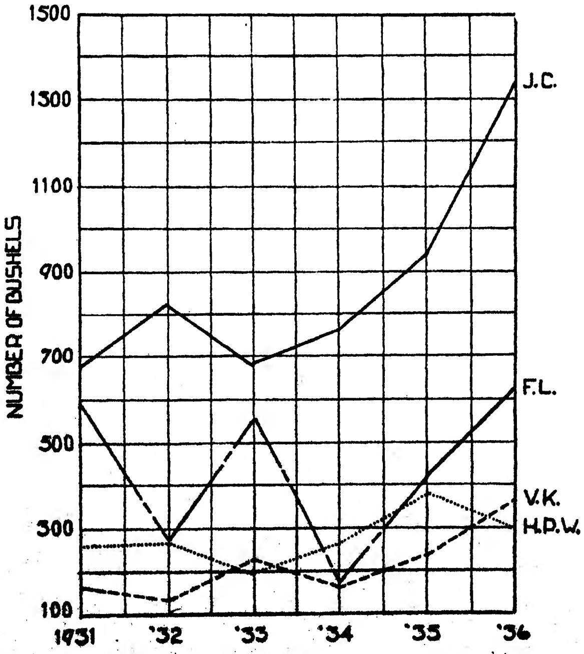

Fig. 1. Graphs showing the annual yields of certain orchards 15 to 25 years old, 1931-36 inclusive.

was interviewed to obtain information on the age and number of crab apple trees in his orchard. From these figures the average yields per tree for 1931 to 1936, inclusive, were determined. (See Table 3 and Fig. 1).

To determine how crab apples grade out as compared with other fruits, all the grading records for all fruits are summarized in Table 2.

Table 2. Comparison of grading percentages for various fruits. Fennville Fruit Exchange.

Kind of Fruit	Year	U.S. No. 1 (bushels)	Total All Grades (bushels)	U.S. No. 1 (per cent)
Crab Apples	1931	5,221	6,531	79.9
Apples	1931	24,752	99,087	24.9
Peaches	1931	17,953	36,204	49.5
Pears	1931	17,199	33,857	50.7
Crab Apples	1932	5,674	7,473	75.9
Apples	1932	44,098	119,062	37.0
Peaches	1932	17,004	41,399	41.0
Pears	1932	36,569	64,203	56.9
Crab Apples	1933	3,554	5,746	61.7
Apples—U. S. F.	1933	17,757	95,840	37.0
Apples—U. S. No. 1	1933	17,757	95,840	37.0
Peaches	1933	807	1,323	60.9
Pears	1933	15,455	27,922	55.3
Crab Apples	1934	2,709	3,217	84.2
Apples	1934	28,243	53,539	52.7
Peaches	1934	—	—	—
Pears	1934	10,404	18,146	57.3
Crab Apples	1935*	4,550	5,165	88.0
Apples	1935	10,582	28,405	37.2
Peaches	1935	3,654	7,711	47.3
Pears	1935	13,574	19,894	68.2
Crab Apples	1936*	6,669	7,569	88.1
Apples—U. S. F.	1936	112	44,282	51.4
Apples—U. S. No. 1	1936	22,657	44,282	51.4
Peaches	1936	1,454	2,271	64.0
Pears	1936	8,582	18,034	47.5

*These figures are based on the yields secured by the principal crab apple growers who are members of the Exchange.

A comparison of U. S. No. 1 crab apple prices with the price of other early competing fruits was made by recording the pool price on U. S. No. 1 crab apples, U. S. No. 1 Bartlett pears and U. S. No. 1 Wealthy apples, along with the average pool price on the various varieties of U. S. No. 1 peaches. (See Table 4).

A comparison of pool prices and production also is shown in Table 4. This table was made by taking the pool prices of U. S. No. 1 peaches, and U. S. No. 1 Wealthy apples and recording the respective total amounts of crab apples, pears, peaches, and apples produced for 1931 to 1936, inclusive. This was done to compare the prices of fruits with the local supply of these fruits. Figures 2, 3 and 4 were made to supplement the tables on production and prices and are intended to show the relation of national and Michigan production of the various fruits, such as apples, pears and peaches, to the price of crab apples. The last three years recorded on the graph represent the production of

Table 3. Individual growers' yields of crab apples per tree for a 6-year period.

Grower	Trees		1931 Yield		1932 Yield		1933 Yield		1934 Yield		1935 Yield		1936 Yield		Average Yield 1931-36
	No.	Age in 1936	Total	Per tree	Total	Per tree	Total	Per tree	Total	Per tree	Total	Per tree	Total	Per tree	
J. C.	500	20	963	1.9	1450	2.9	1172	2.3	1331	2.6	1707	3.4	2512	5.0	3.0
V. K.	118	17	166	1.3	83	.7	259	2.2	154	1.3	300	2.5	529	4.4	2.0
F. H. L.	364	20	596	1.6	363	1.0	953	2.6	190	.5	665	1.8	1048	2.8	1.7
G. M.	350	30	424	1.2	452	1.2	415	1.2	534	1.5	446	1.2	646	1.8	1.3
O. P.	75	25	170	2.2	131	1.7	218	2.9	247	3.2	153	2.0	381	5.0	2.8
E. W.	200	15	336	1.6	495	2.4	—	—	—	—	—	—	—	—	2.0
S. W.	175	15	190	1.0	296	1.6	—	—	—	—	—	—	—	—	1.3
H. P. W.	81	20	336	4.1	364	4.4	203	2.5	360	4.4	594	7.4	419	5.1	4.6
F. L.	50	20	85	1.7	115	2.3	122	2.4	133	2.6	147	2.9	210	4.2	2.6
E. R.	98	12	132	1.3	46	.5	—	—	—	—	—	—	—	—	.9
R. V.	30	30	137	4.5	91	3.3	41	1.3	139	4.6	—	—	93	3.1	3.6
E. L.	125	20	161	1.2	210	1.6	190	1.5	335	2.6	279	2.2	451	3.6	2.1
T. G.	152	28	143	.9	543	3.5	357	2.3	727	4.7	506	3.3	966	6.3	3.5
Average				1.8		2.0		2.1		2.8		2.9		4.1	2.6

Average annual yield for 6 years—2.6 bushels.

Table 4. Average prices received for crab apples and some of the competing fruits, Fennville Fruit Exchange.

Year	Average Crab Apple Prices	Crab Apple Produced (bushels)	Average Bartlett Prices	Pears Produced (bushels)	Average Peach Prices	Peaches Produced (bushels)	Average Apple Prices	Apples Produced (bushels)
1931	$0.85	6,531	$0.68	33,857	$0.80	36,204	$0.85	99,087
1932	1.00	7,473	1.40	64,203	.70	41,399	.70	119,062
1933	1.00	5,746	1.50	27,922	1.80	1,323	.60	95,840
1934*	1.30	3,217	1.60	18,146	no crop	no crop	1.15	53,539
1935*	.70	5,165	1.50	19,894	1.00	7,711	.80	28,405
1936*	.80	7,569	1.50	18,034	1.35	2,271	1.00	44,282

*These figures are for the principal crab apple growers in the Exchange and not for the entire membership.

the orchards of the principal crab apple growers and not the entire membership of the Exchange.

The costs per bushel for washing, handling, grading and package for crab apples were obtained from the Fennville Fruit Exchange accounts. The cost per bushel for picking was determined from the daily wage rate and the average amounts picked by one man per day. These charges are shown in Table 5.

The marketing costs recorded in Table 5 were transferred to Table 6, along with the price received per bushel of crab apples and the average

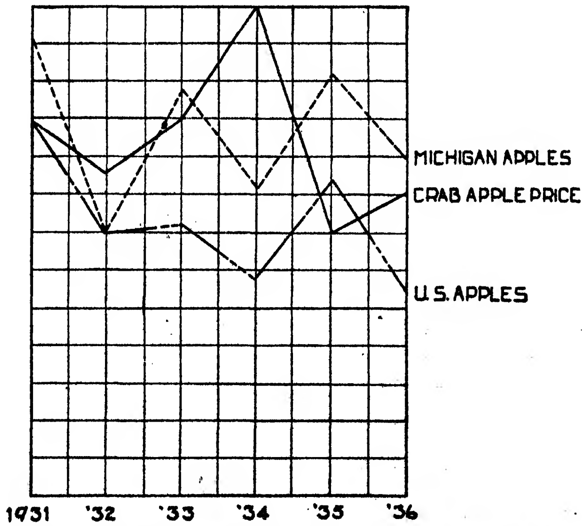

Fig. 2. Graphs showing total U. S. production of apples, total Michigan apple production and the local crab apple prices, 1931-36 inclusive. (Each square represents: 20,000,000 bushel production on the U. S. apple curve, 800,000 bushel production on the Michigan apple curve and 10 cents on the crab apple price curve.) (The production figures were obtained from Yearbook of Agriculture.)

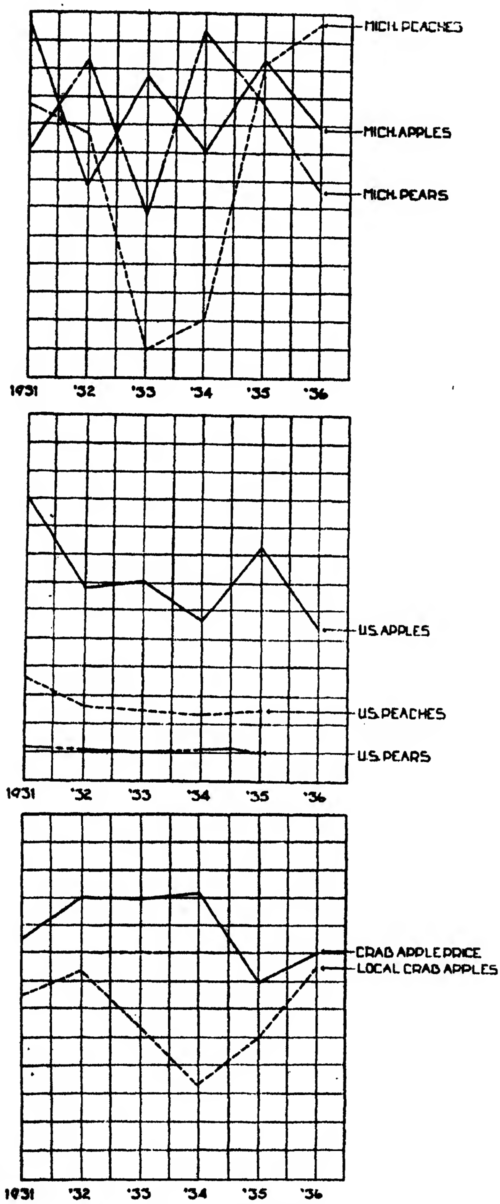

Fig. 3. Graphs showing United States and Michigan production of apples, pears, peaches and crab apples and local crab apple prices. (Each square represents: 20,000,000 bushel production on the U. S. apple, peach and pear curves, 800,000 bushel production on the Michigan apple curve, 200,000 bushel production on the Michigan peach curve, 60,000 bushel production on the Michigan pear curve, 1,000 bushel production on the local crab apple curve, 10 cents on the crab apple price curve.) (The production figures were obtained from Year-book of Agriculture.)

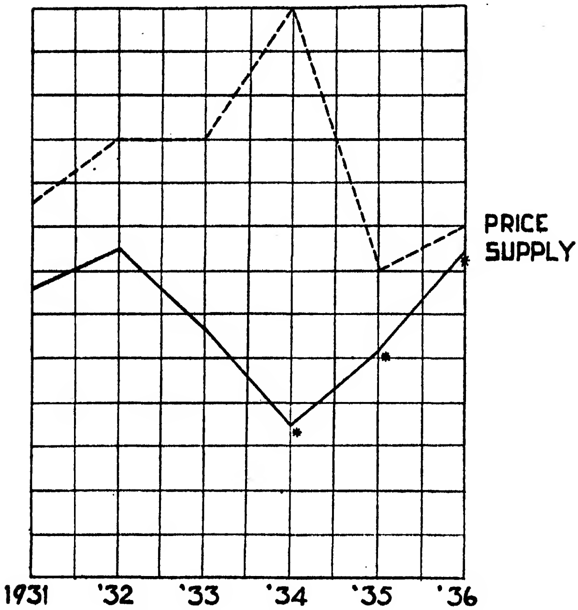

Fig. 4. Graphs showing the relation of crab apple prices to the local supply of crab apples. (Each square represents: 1,000 bushel production on the supply curve, 10 cents on the price curve.)

annual yield per tree to obtain information on the return per tree and per acre from crab apple orchards. The return per tree and the return per acre are figured as the difference between gross income for these units and the marketing costs. Production costs such as for pruning, spraying, cultivating and thinning have not been accounted for in these returns.

Presentation of Data

Total Returns and Relative Importance—The relative commercial importance of the crab apple in the Fennville section, as determined from data collected from the records of the Fruit Exchange, was fifth among the kinds of fruit handled by this Exchange. The gross income from crab apples was 4.4 per cent of the total gross income from the

Table 5. Annual packing and handling costs per bushel, Fennville Fruit Exchange.

	1931	1932	1933	1934	1935	1936
Washing	$0.01	$0.01	$0.01½	$0.01½	$0.02	$0.02½
Handling and Grading	.08	.07	.06	.06½	.06½	.07
Package	.17	.15	.15½	.19	.17	.17
Picking	.07½	.06	.10	.10	.12	.12
Total Charge	$0.33½	$0.29	$0.33	$0.37	$0.37½	$0.38½

Table 6. Total marketing costs, prices received, amount left, yield per tree, and the return per acre, for the years 1931 to 1936. These data are for the orchards of the principal crab apple growers in the Fennville area.

Year	Total Handling and Marketing Costs per Bu. U.S. No. 1	Price Received per Bu. U.S. No. 1	Amount Left per Bu. U.S. No. 1	Yield per Tree U.S. No. 1 (bushels)	Income Return per Tree U.S. No. 1	Yield per Tree Culls (bushels)	Price per Bu. Culls	Income Return per Tree Culls	Total Return per Tree	Return per Acre 50 Trees
1931	$0.335	$1.00	$0.665	1.4	$0.95	.4	$0.10	$0.04	$0.99	$49.50
1932	.29	.85	.56	1.5	.84	.5	.15	.07	.91	45.50
1933	.33	1.00	.67	1.3	.87	.8	.25	.20	1.07	53.50
1934	.37	1.30	.93	2.0	1.86	.8	.45	.36	2.22	111.00
1935	.375	.70	.33	2.1	.69	.8	.25	.20	.89	44.50
1936	.385	.80	.43	3.0	1.29	1.1	.25	.27	1.56	78.00
Average	$0.345	$0.94	$0.595	2.2	$1.08	.7	$0.24	$0.19	$1.27	$63.66

NOTE:—The above returns per acre and per tree are figured as the difference between gross income and marketing costs. Production costs such as spraying, cultivation, pruning, etc. have not been subtracted.

sale of all kinds of fruit by this marketing organization (Table 1). The figures in part A of this table show the gross returns from the various kinds of fruits sold by the entire membership of the Exchange for the years 1931 to 1933, inclusive, when the members numbered 79, 75 and 61, respectively. Part B of Table 1 shows the returns of the principal crab apple growers of the Exchange from the various fruits which they produced. These leading crab apple growers were also the largest growers of other fruits, having received 36.6 per cent of the gross returns of the Exchange for the period of 1931 to 1933 and 61 per cent of the gross returns from crab apple sales for this same period. This same group of growers, 16.9 per cent of the Exchange membership, with the larger incomes received 6.8 per cent of their total gross revenue from their orchards for the years 1934 to 1936 from the sale of crab apples. One of them with a gross income varying from $10,000 to $12,000 annually received 12 per cent of this total gross income from the sale of crab apples.

Table No. 1 shows that none of the other fruit crops raised in the Fennville area yielded as regular an income year after year as crab apples. Peaches, cherries, grapes and plums, in the order named, were the least stable as sources of income. This fluctuation in annual returns from these different fruits may be attributed to severe winters and attendant winter injury to trees or their flower buds, to spring frosts, to a marked tendency toward biennial bearing, and to low prices during the years of heaviest production. Crab apples are hardy and may be depended upon more than any of the other fruits to produce more even sized crops year after year.

Grading Records—One of the characteristics of crab apples as a fruit crop is their relatively high grading percentage. A comparison of the grading percentages for crab apples, apples, pears and peaches, as given in Table 2, shows that crab apples grade out the best of those four fruits. The percentage of U. S. No. 1 crab apples was 72.5 for the entire membership of the Exchange for the years 1931 to 1933, inclusive, while for the principal crab apple growers of the Exchange for the years 1934 to 1936, inclusive, it was 86.7. The average grading percentage for pears was 55.9, peaches 52, and for apples, 40, during this same period.

The high grading percentage for crab apples may be attributed in considerable part to the rather uniform size of the fruit. It was observed that very few crab apples were culled for lack of size. The Hyslop variety is also known for its good color. Furthermore, it is the writer's opinion that it is easier to produce crab apples free from scab and worm injury than other tree fruits because of the slower rate at which the fruit grows, thereby increasing the effectiveness of fungicides and insecticides. The amount of spray residue on crab apples is probably greater than the amount of spray residue on other fruits. This supposition is supported somewhat by the concern of some growers as to whether their crab apples will pass the tolerance test for arsenic and lead for marketable fruit. Some growers make a rough estimate of the amount of spray residue on their other varieties of apples by the amounts of lead and arsenic found on crab apples. Growers believe that if their crab apples are below the tolerance limit

for these spray materials their other varieties of apples will also be below that tolerance limit.

Yields—Yields of crab apples produced in the orchards included in this study are shown in Table 3. As would be expected, there is much variation. For instance, the crab apple trees in the orchard of H. P. W. consistently out-yielded the trees belonging to G. M. This difference may be attributed to the difference in the methods practiced by the two growers. The annual yields of crab apples for the orchards of the principal growers showed a gradual increase as the trees became older, some of which probably was due to the growth of the tree, some to climatic and other factors. In 1936, the last year for which yields were recorded, most growers obtained relatively large yields. The average yield for that year was 4.1 bushels per tree, while the lowest yield was obtained in 1931 with an average of 1.8 bushels per tree. One grower obtained as large a yield of fruit from trees 7 years old as a number of other growers obtained from trees ranging in age from 10 to 30 years. A yield of 23 bushels was obtained from one 35-year-old tree in the orchard of a grower who was not a member of the Exchange. Individual crab apple trees often show more or less of a biennial habit of fruiting and this may extend to entire orchards. This is shown in the slight alternation of somewhat larger and somewhat smaller yields of the orchards for which records are presented in Table. 3.

Prices—A study of the prices of crab apples and other fruits going on the market at about the same time shows that crab apple prices are more or less independent of the prices received for other fruits (see Table 4), though it is evident that crab apple prices follow somewhat those of the other fruits. Perhaps the most noticeable feature about them is that they show less extreme variation from year to year.

The price of crab apples in any one year shows some relation both to the annual production of apples in the United States and in Michigan. Figure 2 shows that this was more evident during the period of 1933 to 1936, inclusive, than during the period 1931 to 1933. Figure 3, showing the production of apples, pears, and peaches for Michigan and the United States, along with crab apple prices, indicates very little relationship between crab apple prices and the production of pears and peaches in the United States or Michigan, while the price of crab apples shows a tendency to vary inversely with the total apple production in the United States.

Local production of crab apples apparently has very little effect on their price (see Figure 4). The first three years recorded on the graph are for the production of the entire membership of the Exchange, while the last three years are for that of the principal crab apple grower. However, the principal crab apple growers produced 61 per cent of the crab apples sold by the Exchange and for this reason the production of crab apples for the entire membership would be considerably greater than that recorded for the last three years. Nineteen thirty-six was the year of the greatest local production, yet the price was 10 cents per bushel higher than the year before. The annual local production of crab apples will vary between 5,000 and 8,000 bushels per year and apparently that amount is too small to have any considerable influence on the price of crab apples in the midwest markets.

Marketing Costs—The marketing and production costs for crab apples vary from year to year. The charge for washing varied from 1 to 2½ cents per bushel. During 1936 early apples were washed for the minimum rate of 2 cents per bushel, while late varieties of apples, including crab apples, were washed for the maximum rate of 2½ cents per bushel.

The handling and grading charge varied from 6 cents per bushel in 1933 to 8 cents per bushel in 1931. The price of the package varied from 15 cents in 1932 to 19 cents per bushel in 1934. The cost of picking ranged from 6 cents per bushel in 1932 to 12 cents per bushel in 1936. The higher cost of picking in 1936 was due principally to an increase in the wages of the pickers, rather than to a lighter crop and a greater amount of time required to harvest a bushel of fruit.

The total marketing cost was the lowest in 1932, with a charge of 29 cents per bushel for these various services, while in 1936 it was the highest, with a charge of 38½ cents per bushel of crab apples.

Returns—The average yields of U. S. No. 1 crab apples and culls produced per tree, together with the various packing and handling costs and prices per bushel for these grades, were used in determining the income per tree and per acre of 50 trees. It will be noted (Table 6) that the net income per acre before subtracting overhead and current orchard maintenance costs, of crab apples varied from $44.50 in 1935 to $111.00 in 1936. The average return for the six-year period was $63.66 per acre.

Discussion

The raising of orchard fruits in Michigan involves much financial risk. The grower who depends upon only one or two kinds as the principal source of income is accepting more risk than the grower who raises a greater diversity. The production of crab apples on the average fruit farm provides a means of spreading and minimizing this financial risk. On the other hand, the demand for crab apples is about the same year after year; for this reason, it is not advisable greatly to increase the acreage. New plantings should be limited for the most part to replacements of those trees taken out of production.

Summary

1. Though crab apples are a minor fruit crop, they are a popular supplementary fruit crop in the Fennville district of Michigan, 70 per cent of the growers raising them for income.
2. The production of crab apples is about stationary.
3. In comparison with other fruits crab apples are easily grown, as shown by their high grading percentage.
4. Crab apples sell for prices comparable to those paid for apples, but their prices are subject to less fluctuation than those of most other fruits.
5. The trees yield reasonably well and more regularly than those of most apple varieties.
6. The fruits grade considerably better than those of the apple, seldom showing size or color deficiency.
7. Average net returns per tree or per acre are reasonably satisfactory.

CHERRY PRODUCTION COSTS FOR EIGHT MICHIGAN ORCHARDS, 1935-1937

G. N. MOTTS
SECTION OF ECONOMICS

Source of Data—The data on cherry production costs presented in this paper were obtained in connection a study of cherry tree mortality recently completed*. The cost figures were obtained from eight Michigan cherry growers who have for several years cooperated with the Farm Management Department of the college in the Farm Account project. These growers supplied the necessary data from their farm account books and the fruit supplements used in recent years. Though the limited number of orchards included in this paper is not sufficient to indicate accurately an average cost of production for cherries in Michigan, the available cost data for these eight orchards may be of interest until a comprehensive study might be made comparable to the one recently published on apple production costs in Berrien County by Wright and O'Brien**.

The location, acreage and production of red cherries*** in each of the eight orchards are shown in Table 1. The plantings ranged in size from 1.4 to 21 acres of bearing trees of the Montmorency variety and were located as follows: three in the southern Michigan cherry area, two in the central area and three in the Grand Traverse region. All the data apply to the bearing acreage only.

The available data in regard to labor, power and spray materials used per acre for these orchards are presented in Table 2. Since cherry pickers are paid by the pound, no records of man-hours of labor for this operation were available.

Computation of Production Costs Per Acre—The costs of cherry production for these eight Michigan orchards have been classified in this paper in the same manner as that used in the study of apple production costs in Berrien County.

The cost figures for cash expenditures and receipts are the total amounts shown in the farm account books reduced to the cost per acre, while the non-cash costs have been computed from the records of man-hours, tractor-hours, etc. The rates used per man-hour were 20 cents for 1935 and 25 cents for 1936 and 1937; power costs of 10 cents per horse-hour in 1935 and 12 cents in 1936 and 1937, and a rate of 60 cents per tractor-hour for the light two-plow size and 75 cents per hour for the heavy two-plow tractors for each of the three years. The cost of trucking the cherries to market was based on a rate of 7 cents

*Motts, G. N. "Cherry Tree Mortality in Six Michigan Counties, 1930-1938." Mich. Agr. Exp. Sta. Quar. Bul. Nov., 1938.

**Wright, K. T. and O'Brien, W. R. "Cost of Producing Apples in Berrien County, Michigan, 1935." Mich. Agr. Exp. Sta. Spec. Bul. 286. 1937.

***The term "red" cherry has come into use recently to replace "sour" cherry, a term regarded as a handicap to the industry by cherry growers and canners.

Table 1. Location, acreage and production of eight Michigan cherry orchards.

Year	Grower number	County	Bearing acreage	Number of Trees: On farm B	Number of Trees: On farm N-B	Number of Trees: Per acre B	Number of Trees: Per acre N-B	Production (lbs.): Total	Production (lbs.): Per acre	Production (lbs.): Per tree
1935	1	Grand Traverse	21	2,100	150	100	100	157,250	7,488	75
	2	Oceana	14	1,150	500	82	82	8,685	620	*
	3	Antrim	10	966	—	97	—	43,458	4,346	45
	4	Oceana	9	922	490	102	98	16,709	1,857	18
	5	Grand Traverse	6	636	1,378	106	106	43,105	7,184	68
	6	Berrien	3.4	340	—	102	—	4,050	1,191	12
	7	Berrien	2	204	—	102	—	8,924	4,462	48
	8	Berrien	.4	40	—	100	—	—	No Record	
1936	1		—	—	—	—	—	98,079	4,670	47
	2		—	—	—	—	—	10,025	716	9
	3		—	—	—	—	—	42,338	4,234	44
	4		—	—	—	—	—	52,328	5,814	57
	5	As in 1935	—	—	—	—	—	28,135	4,689	44
	6		—	—	—	—	—	250	—	—
	7		—	—	—	—	—	3,350	1,675	16
	8		—	—	—	—	—	1,501	3,752	38
1937	1		—	—	—	—	—	97,000	4,619	46
	2		—	—	—	—	—	17,105	1,222	15
	3		—	—	—	—	—	36,046	3,605	37
	4		—	—	—	—	—	31,584	3,509	34
	5	As in 1936 except for Grower No. 8	—	—	—	—	—	45,974	7,662	72
	6		—	—	—	—	—	20,497	6,028	60
	7		—	—	—	—	—	26,000	13,000	127
	8		1.4	140	—	100	—	9,050	6,464	65

*Less than one pound per tree.

Table 2. Labor, power and spray used per acre for eight Michigan cherry orchards, 1935-37.

			Man-hours						Horse-hours					Tractor-hours						Spray Used gallons	
Year	Grower No.	Bearing Acreage	Pruning	Fertilizing	Cultivating	Spraying	Marketing	Total (except picking)	Pruning	Fertilizing	Cultivating	Spraying	Total (except picking)	Pruning	Fertilizing	Cultivating	Spraying	Total (except picking)	Truck Miles Marketing	Total	Per Tree
1935	1	21	21.40	1.65	4.75	14.30	11.90	54.00	—	—	—	—	—	1.81	.57	4.76	4.76	11.90	88	20,000	9.52
	2	14	5.70	.35	4.30	5.80	1.80	17.95	.57	—	7.00	5.71	13.28	—	—	.71	—	.71	5	6,000	4.28
	3	10	10.00	3.50	2.50	7.00	4.00	27.00	—	—	—	—	—	—	—	2.50	3.50	5.00	17	7,500	7.50
	4	9	13.90	.55	13.35	7.20	11.10	46.10	2.00	.56	13.33	7.00	22.89	—	—	—	—	—	10	4,800	5.33
	5	6	5.00	3.35	13.35	2.50	10.00	34.20	—	8.33	10.00	—	18.33	—	—	16.67	3.33	20.00	14	1,000	1.67
	6	3.4	8.80	1.45	2.95	2.95	1.45	17.60	—	—	—	—	—	—	—	3.53	4.71	8.24	4	3,500	10.29
	7	2	10.00	5.00	10.00	10.00	15.00	50.00	4.00	4.00	20.00	18.00	46.00	—	—	—	—	—	36	No Record	
	8	.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	No Record	
1935 Average.....			10.69	2.26	7.31	7.11	7.89	35.26	—	—	—	—	—	—	—	—	—	—	25	8,133	6.43
1936	1	21	16.96	1.72	5.32	11.80	8.56	44.36	—	—	—	—	—	1.33	.25	5.25	4.29	11.12	48	20,000	9.52
	2	14	—	—	—	4.28	2.28	6.56	—	—	—	4.44	4.44	—	—	—	—	—	5	4,650	3.32
	3	10	12.00	3.20	3.20	8.00	3.80	30.20	—	—	—	—	—	—	1.00	3.00	4.00	8.00	17	9,000	9.00
	4	9	—	1.16	2.36	3.52	24.88	31.92	2.22	.56	13.67	7.67	24.12	—	—	—	—	—	22	6,400	7.11
	5	6	4.68	3.32	11.33	2.68	10.00	32.01	—	9.17	8.33	—	17.50	—	—	16.67	4.17	20.84	17	1,200	2.00
	6	3.4	—	1.16	2.36	3.52	*	*7.04	—	—	—	—	—	—	—	3.53	4.71	8.24	*	4,000	1.18
	7	2	10.00	4.00	10.00	8.00	4.00	36.00	4.00	4.00	20.00	18.00	46.00	—	—	—	—	—	21	No Record	
	8	.4	4.00	30.00	4.00	4.00	2.00	44.00	—	—	4.28	6.43	10.71	—	—	—	—	—	36	450	11.25
1936 Average.....			5.96	5.57	4.82	5.72	7.85	29.92	—	—	—	—	—	—	—	—	—	—	24	6,529	6.20
1937	1	21	24.40	5.72	4.56	16.76	9.52	60.96	—	—	—	—	—	2.00	1.00	4.52	5.71	13.23	65	22,000	10.48
	2	14	—	.28	—	3.72	2.88	6.88	—	—	—	3.71	3.71	—	—	—	—	—	7	3,900	2.78
	3	10	20.00	4.80	3.20	8.00	4.40	40.40	—	—	—	—	—	—	1.50	3.00	4.00	8.50	19	8,375	8.38
	4	9	13.76	.44	4.44	3.56	16.88	39.08	—	—	—	—	—	1.11	.44	4.67	3.33	9.55	14	6,400	7.11
	5	6	8.00	4.00	14.00	2.68	14.68	43.36	—	13.33	8.33	—	21.66	—	—	16.67	5.00	21.67	24	1,300	2.17
	6	3.4	9.40	1.16	2.36	4.72	5.88	23.52	—	—	—	—	—	—	—	3.53	4.71	8.24	12	5,050	1.48
	7	2	10.00	4.00	10.00	8.00	16.00	48.00	4.00	4.00	20.00	18.00	46.00	—	—	—	—	—	50	No Record	
	8	1.4	11.44	8.56	14.28	11.44	14.28	60.00	—	—	14.28	21.42	35.70	—	—	—	—	—	41	1,500	10.71
1937 Average.....			12.12	3.62	6.60	7.36	10.56	40.26	—	—	—	—	—	—	—	—	—	—	29	6,932	6.16
3 Year Average....			9.54	3.88	6.20	6.71	*8.85	*36.07	—	—	—	—	—	—	—	—	—	—	26	6,851	6.25

*No crop in this orchard in 1936; thus figures are omitted from the averages for items directly dependent on yield.

per truck-mile. Barnyard manure was charged at $2.50 per ton applied on the field, but distributed over a four-year period: 40 per cent for the first year, 30 per cent for the second, 20 per cent for the third and 10 per cent for the fourth year following its application. In the case of commercial fertilizer the full cost was charged to the single crop for which it was applied. The cost of equipment includes depreciation, repairs, interest on the investment at 5 per cent, fuel and oil, and shelter. For equipment used for other farm enterprises also, the cost is apportioned to the bearing acreage of cherries according to the proportion of its total use there.

The overhead costs were computed in the following manner. The cherry orchard share of the general farm expenses was set at 5 per cent of the total growing, harvesting and marketing costs. These expenses include such items as the farm share of the auto and telephone, labor on miscellaneous jobs, interest and taxes on land in roads, lanes, farmstead, ditches and fences, upkeep of fences and all other miscellaneous expenses that cannot be allocated to some specific enterprise. Complete cost accounts indicate that the foregoing rate is comparable with each farm enterprise's share of these expenses. The farm taxes are pro-rated to the orchard in proportion to the orchard value as a part of the total farm value, rather than upon an acreage basis. Interest on the value of the trees and the land is figured at 5 per cent. The land and trees were valued separately. The value of the trees was estimated by the growers and was intended to approximate the cost of growing the trees to their present age. This appreciation may be from 50 cents to $1 per tree annually until the trees are 10 years old. The value was then considered at that figure for the next five years, after which a depreciation charge of $1 annually was made until the trees were 20 years old. The specific figure used for the annual appreciation in value depends upon the owner's judgment; depending upon soil and climatic factors.

Costs of Production up to Harvesting—The costs of production per acre up to harvesting, computed in the manner previously described, for the eight Michigan Montmorency cherry orchards for the three years 1935 to 1937 are presented in Table 3.

Table 3 includes the annual average costs and the average of the group of orchards for the three-year period, while the last two lines indicate the proportion of the costs up to harvesting and of the total production costs, respectively, that are represented by each of the items in this group of costs. These costs for the orchards included in Table 3 were not greatly different from those for four other Montmorency orchards in Michigan recently cited by Gardner*. The average costs up to harvesting of the orchards in Table 2 were $28.80, $30.56 and $40.58 for the three years, while the average of the four reported by Gardner was $38.65. The costs up to harvesting for the orchards included in Table 3 amounted to 33 per cent of the total production costs.

Harvesting and Marketing Costs—The combined costs of harvesting and marketing the cherry crop amounted to 37 per cent of the total

*Gardner, V. R. Factors Influencing the Yields of Montmorency Cherry Orchards in Michigan. Mich. Agr. Exp. Sta. Spec. Bul. 275. 1936.

Table 3. Cherry costs of production per acre, up to harvesting for eight Michigan orchards, 1935-1937.
(dollars and cents)

Year	Grower Number	Bearing Acreage	Labor				Fertilizer and Manure	Spray Materials	Use of Equipment	Power and Miscellaneous	Total
			Pruning	Fertilizing	Cultivating	Spraying					
1935	1	21	4.28	.33	.95	2.86	11.71	4.28	13.33	12.05	49.79
	2	14	1.14	.07	.86	1.16	.71	1.86	12.14	1.78	19.72
	3	10	2.00	.70	.50	1.40	6.20	3.90	6.70	3.60	25.00
	4	9	2.78	.11	2.67	1.44	2.00	5.22	11.11	5.11	30.44
	5	6	1.00	.67	2.67	.50	2.67	.83	6.33	5.34	20.01
	6	3.4	1.76	.29	.59	.59	1.18	3.82	.59	2.36	11.18
	7	2	2.00	1.00	2.00	2.00	14.00	19.00	1.00	4.50	45.50
	8	.4	—	—	—	—	—	—	—	—	No Record
1935 Average			2.14	.45	1.46	1.42	5.50	5.56	7.31	4.96	28.80
1936	1	21	4.24	.43	1.33	2.95	5.19	10.81	13.10	15.00	53.05
	2	14	—	—	—	1.07	—	1.43	11.87	.43	14.80
	3	10	3.00	.80	.80	2.00	6.50	4.70	7.50	4.80	30.10
	4	9	3.44	.11	3.44	1.89	2.67	6.22	11.11	5.22	34.10
	5	6	1.17	.83	2.83	.67	3.33	1.00	6.83	5.67	22.33
	6	3.4	—	.29	.59	.88	1.18	4.41	.59	2.65	10.59
	7	2	2.50	1.00	2.50	2.00	14.00	19.00	1.00	5.50	47.50
	8	.4	1.00	7.50	1.00	1.00	—	6.00	12.50	3.00	32.00
1936 Average			1.92	1.37	1.56	1.56	4.11	6.70	8.06	5.28	30.56
1937	1	21	6.10	1.43	1.14	4.19	7.05	11.90	14.05	22.19	68.05
	2	14	—	.07	—	.93	1.64	1.57	11.43	.36	16.00
	3	10	5.00	1.20	.80	2.00	10.50	4.30	10.60	5.10	39.50
	4	9	3.44	.11	1.11	.89	3.33	3.89	11.11	8.56	32.44
	5	6	2.00	1.00	3.50	.67	4.17	2.00	7.67	6.00	27.01
	6	3.4	2.35	.29	.59	1.18	1.76	5.59	.59	3.24	15.59
	7	2	2.50	1.00	2.50	2.00	14.00	19.00	1.00	5.50	47.50
	8	1.4	2.86	2.14	3.57	2.86	33.57	20.00	3.57	10.00	78.57
1937 Average			3.03	.91	1.65	1.84	9.50	8.53	7.50	7.62	40.58
3-Year Average			2.37	.93	1.56	1.61	6.41	6.99	7.64	6.00	33.51
Per cent of Growing costs			7	3	4+	4+	19	21	23	18	100
Per cent of Total costs			2	1	1+	1+	6	7	8	6	33

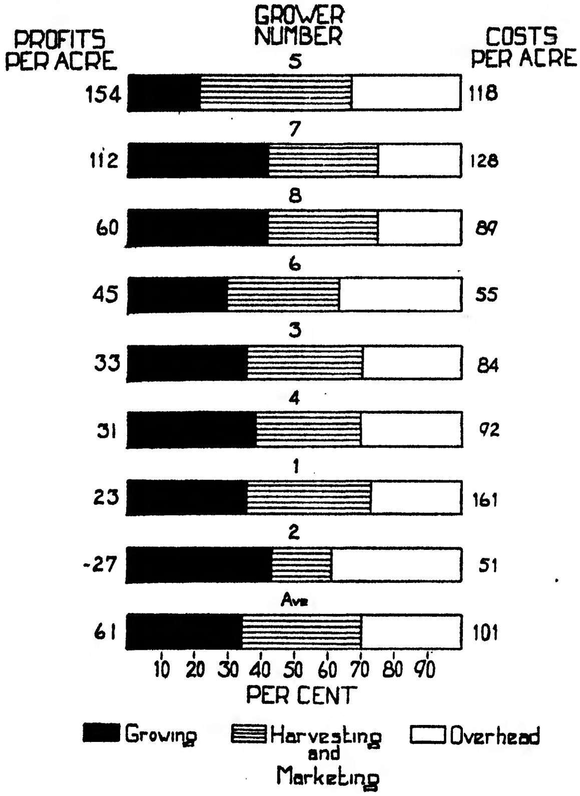

Fig. 1. Relative importance of major production costs for eight Michigan cherry orchards, 1935-37.

costs for the eight orchards, as shown in Table 4. The picking charge greatly predominates in this group of costs since the cherries are nearly all sold to nearby canners, thus largely eliminating package costs and keeping the transportation cost low.

Overhead Costs—The overhead costs per acre amounted to 30 per cent of the total production costs for the eight orchards. The predominant overhead cost is the interest charged on the value of the trees, which amounted to 59 per cent of the overhead costs or 16 per cent of all costs of production. With two exceptions, the amounts reported for tree depreciation per acre were considerably lower than those presented in the study by Gardner*, and are probably too low to be representative of the state as a whole. It is largely for this reason that the three-year average overhead costs for the orchards in Table 4 was $30.50 per acre compared with $73.70 for the orchards mentioned in the other study.

In order to compare more readily the relative importance of each of the three groups of costs and their variations among the individual

*Gardner, V. R. Factors Influencing the Yields of Montmorency Cherry Orchards in Michigan. Mich. Agr. Exp. Sta. Spec. Bul. 275. 1936.

Table 4. Cherry costs of production, per acre, for harvesting and marketing and overhead for eight Michigan orchards, 1935-1937.
(dollars and cents)

Year	Grower Number	Bearing Acreage	Harvesting and Marketing					Overhead					
			Labor		Pkgs.	Truck or horse	Total	Share farm expenses	Taxes	Interest		Depr. of trees	Total
			Picking	Marketing						on trees	on land		
1935	1	21	58.80	2.38	4.14	6.19	71.51	6.05	2.62	28.57	5.24	—	42.48
	2	14	4.64	.36	—	.36	5.36	1.21	.57	7.64	.71	—	10.13
	3	10	2.83	.80	—	1.20	4.83	2.80	1.80	14.80	1.50	—	20.90
	4	9	13.89	2.22	—	.67	16.78	2.33	2.78	10.56	1.56	2.22	19.45
	5	6	53.83	2.00	—	1.00	56.83	3.83	1.33	25.00	6.67	1.17	38.00
	6	3.4	12.94	.29	—	.29	13.52	1.18	.88	10.00	2.90	—	14.96
	7	2	17.00	3.00	—	2.50	22.50	3.50	2.50	25.50	1.50	—	33.00
	8	.4	—	—	—	—	—	—	—	—	—	—	No Record
1935 Average			23.42	1.58	.59	1.74	27.33	2.99	1.78	17.44	2.87	.48	25.56
1936	1	21	44.19	2.14	2.38	3.33	52.04	5.28	2.24	28.57	5.28	—	41.37
	2	14	5.36	.57	—	.36	6.29	1.43	.57	6.00	.71	52.22	60.93
	3	10	31.40	.80	—	1.20	33.40	3.20	2.10	17.20	1.50	—	24.00
	4	9	38.22	6.22	—	1.57	46.01	4.00	2.22	10.56	1.57	6.67	25.02
	5	6	35.17	2.50	—	1.17	38.84	3.00	1.33	29.17	6.67	1.17	41.34
	6	3.4	—	—	—	—	—	.59	.88	10.00	2.94	—	14.41
	7	2	12.50	1.00	—	1.50	15.00	3.00	2.00	25.50	1.50	—	32.00
	8	.4	20.00	.50	—	2.50	23.00	7.50	10.00	6.86	2.57	—	26.93
1936 Average			23.35	1.72	.30	1.45	26.82	3.50	2.67	16.73	2.84	7.51	33.25
1937	1	21	51.19	2.38	.48	4.52	58.57	6.33	2.14	28.57	5.28	2.38	44.70
	2	14	9.14	.72	—	.50	10.36	1.28	.50	6.00	.71	—	8.49
	3	10	42.20	1.10	—	1.30	44.60	4.20	2.20	19.60	1.50	—	27.50
	4	9	26.33	4.22	—	1.00	31.55	3.22	1.56	10.56	1.57	23.11	40.02
	5	6	57.50	3.67	—	1.67	62.84	4.50	1.33	33.33	6.67	1.33	47.16
	6	3.4	65.00	1.47	—	.88	67.35	4.12	.88	10.00	2.94	—	17.94
	7	2	97.50	4.00	—	3.50	105.00	7.50	2.00	25.50	1.50	—	36.50
	8	1.4	65.71	3.57	—	2.86	72.14	7.86	2.86	17.14	6.43	—	34.29
1937 Average			51.82	2.64	.06	2.03	56.55	4.88	1.68	18.84	3.32	3.35	32.07
3-Year Average			33.28	2.00	.30	1.74	37.32	3.82	2.06	17.68	3.02	3.92	30.50
Per cent of H. & M. and of overhead costs			89	5	1	5	100	11	6	59	12	12	100
Per cent of total costs			33	2	*	2	37	4	2	16	4	4	30

*Less than one per cent.

growers, the percentages for each are shown in Table 5. The average proportions for each orchard are presented graphically in Fig. 1.

Total Costs per Acre and per Pound—The cherry production costs per acre included in Tables 3 and 4 are totaled in Table 6 to the nearest whole dollar.

The variations among the eight growers in the proportion of their total production costs included in each group of factors are presented in Fig. 1 according to the average profit per acre made by each grower for the three-year period.

In a general way, both Table 6 and Fig. 1 support the recognized principle that the producer with minimum cost for the variable agents is not necessarily the one with the maximum profit; in fact the grower with the lowest cost per acre lost money during this three-year period. The explanation of this situation is found in the greater yields obtained in the orchards on more suitable land and under better care. Although there is a definite limit beyond which further expenditure is not profitable in a particular case, it is also true that up to that particular point a greater expenditure for land, capital or labor will result in a greater return for each unit of expenditure.

As a possible aid to Michigan cherry growers, in general, in adjusting their expenditures a comparison of the costs per acre on the most profitable and least profitable of the orchards is presented in Table 7. Table 7 also includes a comparison of the proportion of the total cost represented by each item between the two growers and with the average for the group of growers. The fundamental importance of high yields in obtaining a low unit cost of production is shown again by the last line of Table 7.

Cherry Production Cost and Price Relationships—The cost of red cherry production per acre and per pound for eight Michigan growers has been presented in the preceding pages, while the prices received by cherry growers of the state in recent years are shown in Table 8.

A consideration of the cost data presented in this study and of the prices recorded in Table 8 confirms Gardner's conclusions in his recent study of cherry yields:* "(1) Though many Montmorency orchards have been, are and undoubtedly will continue yielding a profit, there is a considerable percentage that have been and are financial liabilities and for which there is no prospect of ever being lifted above the submarginal class. Though, for some years to come, new plantings are not warranted on sites and soils of the type that could be classified as average for the Montmorency orchards of today, there is every reason to believe that the cherry enterprise will continue to be profitable on good soils, favorably located and under capable management." It seems at the present time that growers with a cost of 3 cents per pound or more are not reasonably sure of a profit and that new plantings should be undertaken only when a prospective cost of 2.5 cents or less per pound seems assured.

*Gardner, V. R. Factors Influencing the Yields of Montmorency Cherry Orchards in Michigan. Mich. Agr. Exp. Sta. Spec. Bul. 275. 1936.

Table 5. Percentages of total cherry production costs represented by growing, harvesting and marketing, and overhead costs for eight Michigan orchards, 1935-37.

Grower Number	1935			1936			1937			Average		
	Growing	H. & M.	Overhead	Growing	H. & M.	Overhead	Growing	H. & M.	Overhead	Growing	H. & M.	Overhead
1...........	30	44	26	36	36	28	40	34	26	35	38	27
2...........	57	15	28	20	8	71	48	30	22	42	18	40
3...........	33	39	28	34	38	28	35	31	34	34	36	30
4...........	43	25	32	33	45	22	31	30	39	36	33	31
5...........	17	50	33	22	39	39	20	46	34	20	45	35
6...........	27	34	39	40	—	60	16	66	18	28	33	39
7...........	46	22	32	50	16	34	23	57	20	40	32	28
8...........	No Record			39	28	33	42	39	19	40	32	28
Averages....	35	33	32	34	26	40	31	44	25	33	37	30

Table 6. Total cherry production costs, income and profits per acre and per pound for eight Michigan orchards, 1935-1937.

Year	Grower Number	Yield per acre (lbs.)	Per Acre (dollars)			Per Pound (cents)		
			Cost (a)	Income (b)	Profit	Cost	Income (c)	Profit
1935..........	1........	7,488	164	194	30	2.19	2.60	.41
	2........	620	35	16	−19	5.68	2.66	− 3.02
	3........	4,346	51	135	−84	1.75	2.00	.25
	4........	1,857	67	56	−11	3.71	3.00	− .29
	5........	7,184	115	256	141	1.60	2.40	.80
	6........	1,191	40	36	− 4	3.33	3.00	− .33
	7........	4,462	101	121	20	2.26	2.50	.24
	8........	—	—	—	—	—	—	No Record
1935 Average.............		3,878	82	116	34	2.97	2.59	− .38
1936..........	1........	4,670	146	168	22	3.14	3.60	.46
	2........	716	82	24	−58	4.10	3.35	− .75
	3........	4,234	88	190	102	2.07	3.40	1.33
	4........	5,814	105	174	69	1.77	3.00	1.23
	5........	4,689	102	215	113	2.18	3.00	.82
	6........	70	25	—	−25	34.00	3.20	−30.80
	7........	1,675	94	50	−44	5.64	3.00	− 2.64
	8........	3,752	82	112	30	2.18	3.00	.82
1936 Average.............		3,194	91	117	26	3.01 (d)	3.65 (d)	.64 (d)
1937..........	1........	4,619	171	188	17	3.71	4.05	.34
	2........	1,222	35	32	− 3	2.85	2.66	− .19
	3........	3,605	112	192	80	3.10	4.05	.95
	4........	3,509	104	140	36	2.30	4.00	1.70
	5........	7,662	137	346	209	1.79	3.82	2.03
	6........	6,028	101	264	163	1.67	4.38	2.71
	7........	13,000	189	550	361	1.45	4.25	2.80
	8........	6,464	185	274	89	2.86	4.25	1.39
1937 Average.............		5,764	129	248	119	2.47	3.93	1.46
3-Year Average...........		4,296	101	162	61	2.79	3.27 (d)	.48 (d)

(a) From Tables 2 and 3 to the nearest dollar.
(b) Income from fruit only.
(c) Exclusion of grower whose abnormal costs per pound were the result of crop failure.
(d) Average omits extreme cost for grower number 6 in 1936, due to almost complete crop failure.

Table 7. Comparison of production costs on the most and least profitable of eight Michigan cherry orchards, per acre, for 1935 to 1937.

(dollars and cents)

Costs of Production	Most Profitable (No. 5) (a)				Least Profitable (No. 2) (a)				Comparative Percentages (b)		
	1935	1936	1937	Average	1935	1936	1937	Average	Average of eight	No. 5	No. 2
Labor—Pruning	1.00	1.17	2.00	1.39	1.14	—	—	.38	2	1	*
Fertilizing	.67	.83	1.00	.83	.07	—	.07	.05	1	*	*
Cultivating	2.67	2.83	3.50	3.00	.86	—	—	.29	1	2	*
Spraying	.50	.67	.67	.61	1.16	1.07	.93	1.05	1	*	1
Fertilizer and manure	2.67	3.33	4.17	3.39	.71	—	1.64	.78	8	3	1
Spraying equipment	.83	1.00	2.00	1.28	1.86	1.43	1.57	1.62	8	1	3
Use of equipment	6.33	6.83	7.67	6.94	12.14	11.87	11.43	11.78	7	6	26
Power and miscellaneous	5.34	5.67	6.00	5.67	1.78	.43	.36	.86	6	5	1
Total Growing Cost	20.01	22.33	27.01	23.11	19.72	14.71	16.00	16.81	34	20	36
Labor—Picking	53.83	35.17	57.50	48.83	4.64	5.36	9.14	6.38	31	41	12
Marketing	2.00	2.50	3.67	2.72	.36	.57	.72	.55	1	2	1
Truck and horse cost	1.00	1.17	1.67	1.28	.36	.36	.50	.41	1	1	1
Total harvesting and marketing cost	56.83	38.84	62.84	52.83	5.36	6.29	10.36	7.34	33	44	14
Share of general farm expenses	3.83	3.00	4.50	3.78	1.21	1.43	1.28	1.30	4	3	2
Taxes on orchard	1.33	1.33	1.33	1.33	.57	.57	.50	.55	2	1	*
Interest on value of trees	25.00	29.17	33.33	29.17	7.64	6.00	6.00	6.55	19	25	13
Interest on value of land	6.67	6.67	6.67	6.67	.71	.71	.71	.71	4	5	*
Depreciation of trees	1.17	1.17	1.33	1.22	—	52.22	—	17.41	4	1	34
Total overhead cost	38.00	41.34	47.16	42.17	10.13	60.93	8.49	26.52	33	36	50
Total production costs	114.84	102.51	137.01	118.11	35.21	81.93	34.85	50.67	100	100	100
Production per acre (pounds)	7,184	4,689	7,662	6,512	620	716	1,222	853			

(a) See Tables 1 and 2 for further data on these orchards, 1935-1937.
(b) To closest whole percentage.
* Indicate less than one per cent.

Table 8. Red cherry prices per pound received by Michigan growers, 1916-1937.

Year	Cents	Year	Cents	Year	Cents
1916	4.0	1925	5.0	1934	2.1
1917	5.0	1926	—	1935	2.6
1918	7.0	1927	8.5	1936	3.2
1919	11.0	1928	6.9	1937	3.9
1920	8.0	1929	7.7		
1921	10.5	1930	5.7	Average	
1922	6.0	1931	2.1	1916-37	5.4
1923	6.0	1932	1.4	1921-30	6.8
1924	5.0	1933	2.3	1931-37	2.5

Sources: 1916-25..........Mich. Agr. Exp. Sta. Bul. 166
1926.............Unavailable
1927-34..........Mich. Agr. Exp. Sta. Bul. 258
1935-37..........Average price received by eight growers reporting cherry costs in this study.

A QUICK METHOD OF PREDETERMINING THE CULINARY QUALITY OF POTATOES, WITH SPECIAL REFERENCE TO COLOR

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Use of several varieties by growers producing Michigan's potato crop and the wide fluctuation in environment, soil, and production practices, make it difficult to standardize potato quality. Size and shape of tuber influence any study of quality, but far more important to the consumer is the production of potatoes which will be of good quality when cooked and ready to eat. One of the chief difficulties is to retain a definite white color of the potatoes after cooking, rather than shades of gray, brown or black. To date, the most widely used method for determining quality of a given lot of potatoes is to cook some of them. Because of the amount of work involved this method necessarily reduces the number of samples which can be tested. A quick test which would give some indication of cooking quality would be a great aid in evaluating new varieties and in determining the effect of various cultural practices on cooking quality.

While pickling some small sections of seedling potatoes of varied cooking quality for microscopic examination it was found that a solution of formalin alcohol brought about a decided difference in color and shrinkage of the small sections of tubers from the various lots. On further test, it was found that 95 per cent ethyl alcohol alone would show these differences and that these checked very closely with the results obtained from actual cooking tests. Three plugs were extracted from each of four tubers representing the sample to be tested by thrusting a three-eighths-inch by six-inch brass cylinder through the stem end, seed end, and middle portion of the potato.

One-half inch pieces were cut from the ends of each of the three plugs and placed in a one-inch by five-inch glass tube containing 95 per cent ethyl alcohol. The middle portions of the plugs were dis-

Table 1. A comparison of sections soaked in alcohol with their corresponding cooked potatoes.

	Tuber No.	Color of Alcohol Soaked Sections	Color of Cooked Potatoes Boiled
Sample No. 1 (Free from mechanical injury)..........	1	White	White
	2	White	White
	3	Gray	Gray
	4	White	White
Sample No. 2 (Severely bruised)....................	1	Dark	Very Dark
	2	Gray	Dark at Stem End
	3	Gray	Gray
	4	Slightly Dark	Dark

carded because it was found that they did not indicate the possible color of the cooked potato as well as the end pieces which included the skin and the growth ring area.

The plugs from each tuber were kept in separate glass tubes of the alcohol for one hour and then were examined for color and shrinkage. It was observed that tubers whose plugs or sections remained white and firm in the alcohol, cooked white, while those having shrunken and discolored plugs were usually gray or dark colored when boiled.

There was close correlation between color, texture and flavor. Potatoes that cooked white were usually mealy in texture and of good flavor, while those that discolored were often soggy and of poor flavor.

In testing potatoes for cooking quality it was necessary to compare the alcohol-soaked plugs with the cooked product. Four tubers were placed in a screen rack having four compartments. After a tuber was plugged it was peeled and placed in the No. 1 compartment, also the plugs from this same tuber were placed in No. 1 bottle. By keeping an accurate record of each tuber it was possible to obtain a comparison of the two quality testing methods. Several hundred tubers have been

Fig. 1. The potato on the left is one which cooked white and next to it is a test tube containing plugs from the same potato which have been soaked in 95 per cent ethyl alcohol for one hour. On the right is a potato which when cooked turned a dark gray color, and on the left of the tuber are shown the plugs from this tuber. Note shrinkage and color cast of the potato and plugs on the right as compared with those on the left.

tested and they compare very favorably, in that the tubers cooking dark will also have plugs that are dark in alcohol.

Ninety samples of table stock were tested at the Upper Peninsula Potato Show by both the alcohol and actual cooking tests. The time required for the alcohol test was 3 hours and for the cooking test by boiling 2 days. Results of the two tests were similar. In the alcohol 17 samples were white, 60 showed slight discoloration, while 13 were dark. In the cooking test 17 were white, 64 slightly gray and 9 were dark.

An accompanying table presents the comparative results between actual cooking and alcohol testing two samples of Russet Rurals. Sample 1 was selected from a lot of potatoes that was carefully harvested and stored and was free from mechanical injury. Sample 2 was taken from a lot of severely bruised stock that was carelessly handled. It will be noted that the color of the sections soaked in alcohol agree closely with the color of their corresponding cooked potatoes and that tubers in Sample 2 were discolored as a result of mechanical injury.

MICHIGAN FARM BUSINESS SUMMARY—1937

State Summary, Annual Farm Business Report, 1,163 Michigan Farms—1937

H. A. BERG AND C. O. MAY*

Nineteen thirty-seven was the ninth year of the Farm Management Extension Project in Michigan. This project, sponsored by the Farm Management Department of Michigan State College, was a part of the county agricultural agents' extension program in 76 counties.

During the spring of 1937 a total of 1,333 farmers had their farm accounts summarized. An annual farm business report was prepared for each type-of-farming area shown on the map (Fig. 1), with the exception of Area 10. Areas 1 and 6 were combined into one report. A total of 1,163 of the records were included in the area reports. It was necessary to exclude some records as they were on farms of an unusual type, or in some cases, the records were received too late. During the summer of 1938 an area report was returned to each individual. This report made possible a comparison of an individual farm with the average of other farms of a similar size and type, as well as a comparison with the more and less successful farms. It is through these comparisons that a farmer can determine the strong and weak points in his business. A study of these comparisons, in many instances, has aided farmers in making adjustments that have materially increased their incomes.

*E. B. Hill, J. C. Doneth, and L. H. Brown of the Farm Management Department, and the county agricultural agents in 76 counties assisted with this project.

Farm Earnings in 1937

Farm earnings on Michigan accounting farms were less in 1937 than in 1936. The earnings in 1937 were also less than in 1935, but were equal to those for 1934. The total cash receipts for 1937 averaged \$3,358, or \$5 more than for 1936. Cash farm expenses, on the other hand, averaged \$232 a farm more in 1937. The greatest difference, however, was the fact that the inventory increase was only \$155 a farm in 1937 while in 1936 the increase was \$650 or a difference of \$495. This increase in cash expenditures and the difference in inventory increases were largely responsible for the decline in farm earnings from

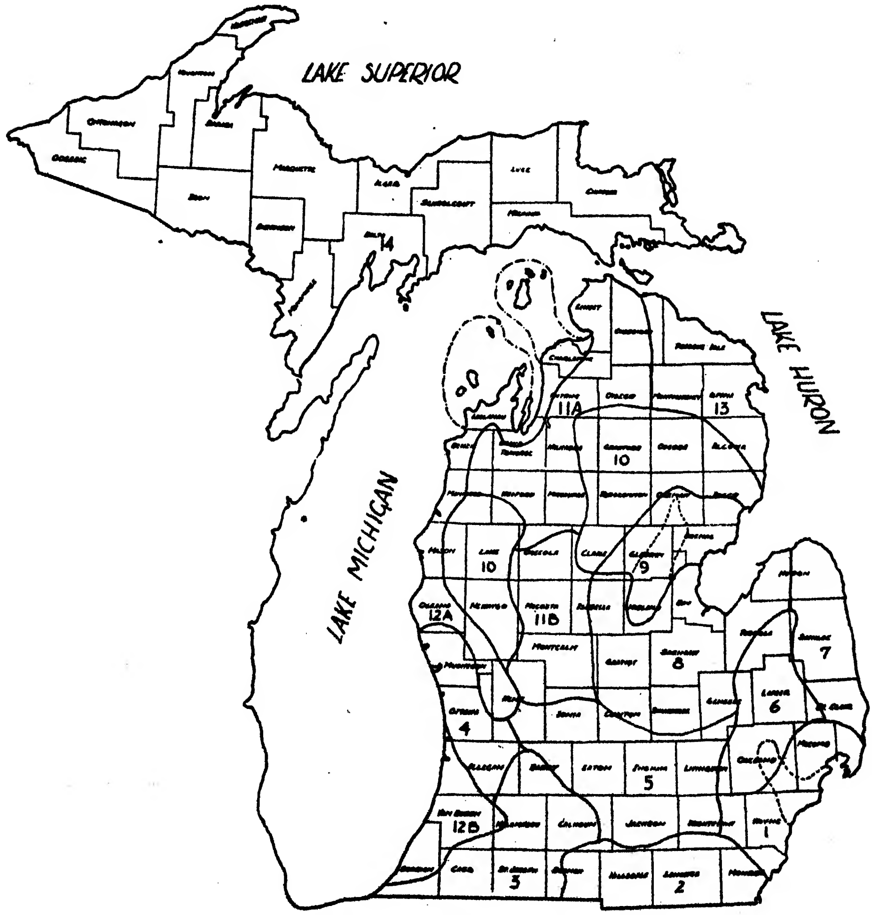

Fig. 1. Type of farming areas in Michigan

1. Dairying
2. Corn and Livestock
3. Small Grains and Livestock
4. Dairying and Poultry
5. General Farming
6. Dairying and Potatoes
7. Cattle, Beans and Hay
8. Beans, Beets and Dairying
9. Cattle, Sheep and Forage
10. Forage and Forestry

11A. and 11B. Potatoes and Cattle

12A. and 12B. Fruit

13. Cattle and Forage
14. Cattle, Forage and Potatoes

an average labor and management wage of $1,318 in 1936 to $569 in 1937.

An analysis of the increase of 1937 cash expenditures over those of 1936 shows that machinery increased $78, feed $53, crop expenses $46, hired labor $43, improvements $7, and miscellaneous $16. Livestock purchases were $11 less in 1937 than in 1936.

During 1937 cash expenditures for improvements and machinery continued to be more than sufficient to offset normal depreciation charges, causing a considerable increase in the inventory values. The inventory value of feeds and crops declined $175 from the beginning of 1937 to the end of the year. This decline was due largely to the drop in the price of grains, beans, and potatoes. The inventory value of livestock was slightly higher at the end of 1937, indicating more livestock on the farms, as the average price of meat animals had dropped approximately 13 per cent by the end of the year.

Some adverse weather conditions occurred in certain areas of Michigan during 1937, despite which most of the crop yields were close to normal. The yields of alfalfa hay, corn, and beans were above normal and decidedly above the 1936 yields. The 1937 wheat yield was below the 1936 yield, while the oat and barley yields were practically the same for both years. Sugar beet yields on accounting farms averaged 2.2 tons an acre less in 1937 than in 1936. The 1937 Michigan Crop Report indicated a near record production of apples, peaches and cherries, while that of plums, pears and grapes was about the average of past years.

There was a decided drop in grain prices during the last five months of 1937, but the average for the year was 17 per cent above the 1936 prices. This was a situation in which most of the purchased feed was bought at high prices during the first six or seven months of the year owing to the drouth in 1936. Following harvest there was not so much need for purchased grains, and grains marketed sold at greatly reduced prices.

The price of meat animals also declined at the end of 1937, but the average price for the year was the highest since 1930. While the average price of meat animals was 9 per cent higher, the average price of grains was 17 per cent higher in 1937 than in 1936, making the feeding ratio less favorable during 1937 than during the previous year. The rapid decline in meat animal prices at the close of the year worked a hardship on many feeders. Many lamb feeders filled their feed lots during the fall with high-priced feeders and were unable to sell at a price high enough to break even. Some cattle feeders who bought heavy, high-priced cattle in the early fall were forced to sell them at a loss.

Variation in Farm Earnings

Table 1 gives a five-year comparison of the financial returns from Michigan farms on which farm accounts have been kept. During 1937 operators of the 1,163 farms included in this report averaged $569 for their labor and management. This earning figure represents what the operator had left for his labor and management after paying all cash operating expenses, allowing for depreciation and other inventory losses, charging for family labor other than his own, and deducting 5 per cent interest on the total investment. This measure of earnings

Table 1. Five-year comparison of financial returns from Michigan farms, 1933-37.

Item	1933	1934	1935	1936	1937
Number of farms	795	845	933	1,055	1,163
Average investment	$11,820	$12,200	$12,510	$12,502	$12,904
Cash receipts	$1,825	$2,389	$2,826	$3,353	$3,358
Cash expenses	1,000	1,324	1,668	1,869	2,101
Net cash income	$825	$1,065	$1,158	$1,484	$1,257
Net change in inventory	153	252	398	650	155
FARM FAMILY INCOME	$978	$1,317	$1,556	$2,134	$1,412
Less: Unpaid family labor	138	142	166	191	198
NET FARM INCOME	$840	$1,175	$1,390	$1,943	$1,214
Less: Operator's labor	420	418	432	538	528
Return for investment and management	$420	$757	$958	$1,405	$686
RATE EARNED ON INVESTMENT	3.56%	6.21%	7.66%	11.24%	5.3%
NET FARM INCOME	$840	$1,175	$1,390	$1,943	$1,214
Less: Interest on investment @ 5%	591	610	626	625	645
OPERATOR'S LABOR AND MANAGEMENT WAGE	249	565	764	1,318	569

does not include any credit for the farm products retained for use by the family.

The accompanying graph (Fig. 2) shows the distribution of the incomes on the 1,163 farms on which records were kept during 1937,

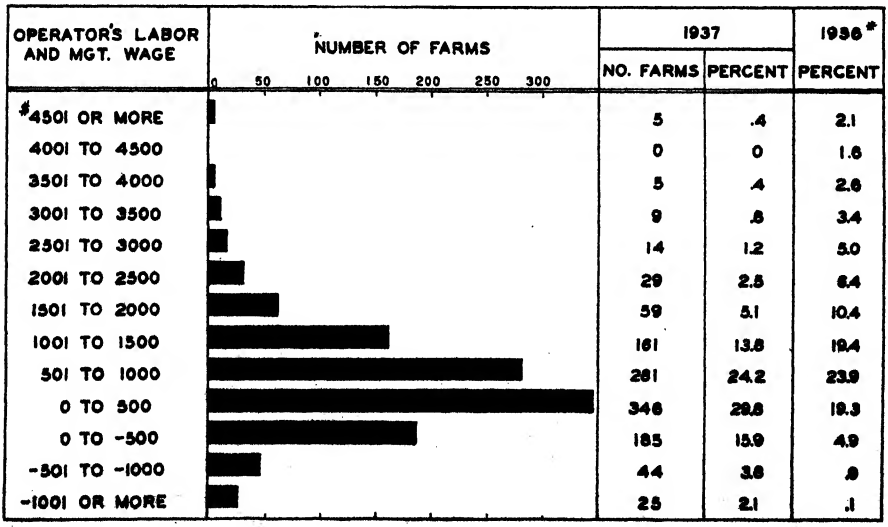

Fig. 2. Distribution of operator's labor and management wage, 1937.

*These percentages show the distribution of operator's labor and management wage of 1,055 farm account cooperators who had records summarized for 1936.

Table 2. Comparison of distribution of operator's labor and management wage, 1929-37.

Year	1929	1930	1931	1932	1933	1934	1935	1936	1937
Number of farms	427	771	925	831	795	845	933	1,055	1,163
Operator's labor and management	Percentage of farms in each income group								
$1,001 or more	25%	6%	1%	1%	10%	23%	31%	51%	24%
1 to 1,000	52	32	16	12	55	56	56	43	54
0 or less	23	62	83	87	35	21	13	6	22

while Table 2 gives a comparison of the earnings of farm account co-operators for each year 1929-37 inclusive.

Farm Investments

AVERAGE OF 1,163 FARMS

Land	$5,042
Buildings (less house)	3,315
Orchard	633
Livestock	1,675
Machinery	1,227
Feed	1,012
TOTAL INVESTMENTS	$12,904

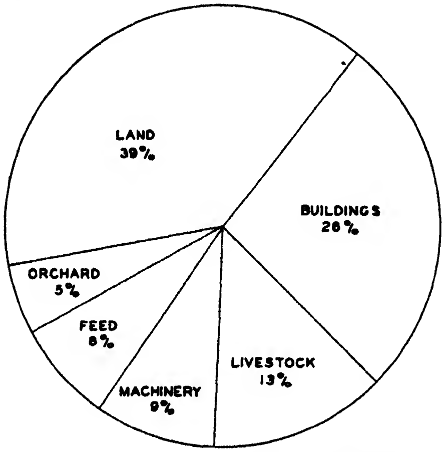

Fig. 3. Farm investments. Average of all farms in report.

Figure 3 indicates the average distribution of the capital invested in the 1,163 farm businesses represented in this report. The average size of these farms was 158 acres, of which 104 acres were tillable. The total inventory valuation of the real estate, livestock, machinery, and feed was $12,904. The real estate including land, orchard, and buildings (less house) composed 70 per cent of the total investment. This 70 per cent is more or less a fixed investment while the remaining 30 per cent is semi-fixed or operating.

Farm Receipts

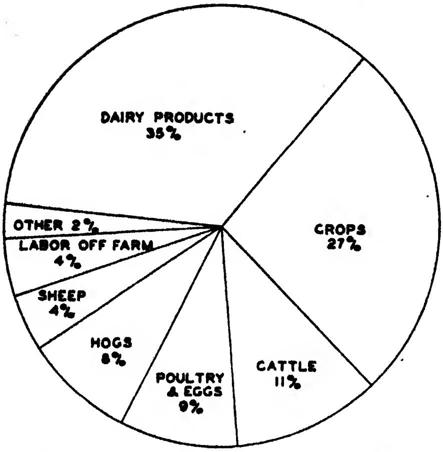

Fig. 4. Farm receipts. Average of all farms in report.

Average of 1,163 Farms

Crops	$730
Dairy products	974
Cattle	293
Poultry and eggs	256
Hogs	230
Sheep	114
Labor off farm	119
Other receipts	45
GROSS INCOME	$2,761

During 1937, 67 per cent of the receipts on these farms came from livestock, 27 per cent from the sale of crops, 4 per cent from labor off the farm, and 2 per cent from miscellaneous sources (Fig. 4). The percentage of the total income obtained from crops was 27 per cent in 1937 as compared with 37 per cent in 1936 when crop prices were relatively high.

Farm Expenses

Average of 1,163 Farms

Operator's labor	$528
Feed bought	313
Machinery	298
Hired labor	259
Crops	218
Family labor	198
Buildings	131
Taxes	71
Other	59
TOTAL EXPENSES	$2,075

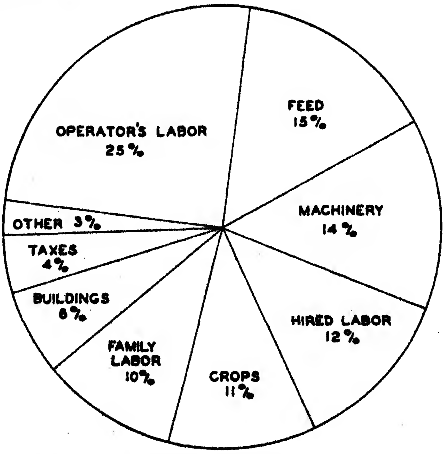

Fig. 5. Farm expenses: Average of all farms in report.

Figure 5 shows the relative importance of the expenses involved in operating a farm business. The figures shown for family labor and operator's labor were calculated at approximately hired wage rates, and do not represent actual cash expenses. The charges made for labor

Table 3. Acreages, investments, and financial summary on 1,163 Michigan farms by type-of-farming areas, 1937.

Type-of-Farming Areas	All Farms	2	3	4	5	6	7	8	9	11A	11B	12AN	12AS Gen.	Comm. Fruit	13	14	Chippewa Mackinac
Number of farms	1,163	89	86	45	173	63	30	119	55	89	42	46	64	124	41	77	20
Total acres	158	177	181	115	179	158	175	138	174	181	214	154	125	109	171	144	195
Per cent of land owned	80	76	72	79	72	70	91	78	78	87	80	93	77	86	94	96	88
Per cent of farm area tillable	66	73	75	76	71	73	81	75	54	53	56	60	69	71	48	37	66
Tillable acres	104	130	135	88	127	115	141	104	94	96	119	92	87	77	82	54	128
Capital Investments, Total	$12,904	$16,249	$14,777	$11,400	$15,882	$15,886	$15,104	$15,257	$9,431	$7,924	$11,881	$8,330	$9,770	$14,895	$7,408	$8,594	$10,798
Real estate (less house)	8,990	10,652	10,555	7,650	10,891	11,366	9,845	10,768	6,294	5,011	8,059	5,426	6,786	12,004	4,579	5,699	7,477
Machinery and equipment	1,227	1,351	1,189	1,010	1,350	1,248	1,544	1,399	979	941	1,064	1,070	886	.1,439	963	1,338	1,236
Feed, crops and supplies	1,012	1,622	1,157	1,039	1,379	1,285	1,370	1,336	524	887	1,055	569	698	642	572	374	580
Livestock (includes horses)	1,675	2,624	1,876	1,701	2,262	1,987	2,345	1,754	1,634	1,085	1,703	1,265	1,400	810	1,294	1,183	1,505
Cash Receipts, Total	$3,358	$5,114	$3,622	$3,273	$3,995	$3,770	$4,195	$3,617	$2,117	$2,104	$2,889	$2,190	$2,603	$4,112	$1,861	$2,198	$2,938
Livestock sales, total	2,147	4,073	2,567	2,733	2,933	2,728	2,994	2,110	1,527	1,147	1,828	1,532	1,876	951	1,110	1,457	2,056
Crop sales	906	653	720	286	763	756	795	1,190	359	704	843	438	523	2,857	460	304	355
Labor off farm	119	92	129	85	101	94	133	119	112	103	76	76	97	124	174	223	306
Other receipts	186	296	206	169	198	192	273	198	119	150	142	144	107	180	117	214	221
Cash Expenses, Total	$2,101	$3,753	$2,375	$2,060	$2,354	$2,340	$2,471	$2,068	$1,248	$1,278	$1,628	$1,330	$1,496	$2,833	$1,059	$1,339	$1,616
Farm improvements	236	378	254	244	270	258	214	317	167	197	234	94	134	266	125	142	101
Machinery and equipment	624	879	622	473	661	788	991	693	466	460	524	420	467	712	434	517	617
Livestock purchases	321	1,085	397	267	469	319	440	266	189	133	251	203	162	136	153	72	197
Feed bought	313	650	479	602	345	286	273	192	141	187	194	212	342	243	97	323	293
Hired labor	259	349	232	193	226	280	157	228	96	111	173	199	158	779	97	96	194
Crop expense	218	238	231	153	235	228	247	243	104	126	137	121	137	507	91	112	114
Taxes	71	96	95	64	80	94	87	77	54	43	77	52	57	74	41	37	61
Other expenses	59	78	65	64	68	87	62	52	31	21	38	29	39	116	21	40	39
Net Change in Inventory	$155	$106	$357	$218	$53	$115	$388	$251	$281	—$104	— $53	— $22	$54	$511	$20	$18	$20
Improvements (includes orchard)	120	209	92	116	91	113	50	165	69	98	100	9	21	320	39	47	— 10
Machinery and equipment	177	268	166	111	203	239	384	202	161	127	162	68	127	173	114	91	136
Feed, crops, and supplies	—175	—442	22	—109	—258	—311	— 91	—140	33	—360	—358	—135	—140	5	—170	— 98	—168
Livestock (includes horses)	33	71	77	100	17	24	45	24	18	31	43	36	46	13	37	— 22	62
Net Cash Income	$1,257	$1,361	$1,247	$1,213	$1,641	$1,430	$1,724	$1,549	$869	$826	$1,261	$860	$1,107	$1,279	$802	$859	$1,322
Plus: Inventory Increase	155	106	357	218	53	115	388	251	281	—104	— 53	— 22	54	511	20	18	20
Farm Family Income	1,412	1,467	1,604	1,431	1,694	1,545	2,112	1,800	1,150	722	1,208	838	1,161	1,790	822	877	1,342
Less: Unpaid family labor	198	160	199	123	180	231	232	189	183	164	253	168	219	205	186	303	198
Net Farm Income	1,214	1,307	1,405	1,308	1,514	1,314	1,880	1,611	967	558	955	670	942	1,585	636	574	1,144
Less: Interest at 5%	645	812	739	570	794	794	755	.763	472	396	594	417	488	745	370	430	540
Operator's Labor and Management Wage—1937	569	495	666	738	720	520	1,125	848	495	162	361	253	454	840	266	144	604
Operator's Labor and Management Wage—1936	$1,318	$1,777	$1,106	$1,138	$1,512	....	$1,940	$1,899	$852	$945	$1,228	$770	$934	....	$841	$620	$1,241
Operator's Labor and Management Wage—1935	764	1,566	751	644	1,007	....	687	912	464	456	769	471	506	....	—	428	633

Table 4. Percentage of land in different crops and crop yields by type-of-farming areas, 1937.

Type-of-Farming Areas	All Farms	2	3	4	5	6	7	8	9	11A	11B	12AN	12AS Gen.	Comm. Fruit	13	14	Chippewa Mackinac
Number of farms	1,163	89	86	45	173	63	30	119	55	89	42	46	64	124	41	77	20
Number tillable acres	104	130	135	88	127	115	141	104	94	96	119	92	87	77	82	54	128
Per cent tillable acres in hay, seed, and pasture	43	37	38	42	41	44	49	32	51	53	51	56	46	27	60	60	60
Per cent tillable acres in legumes*	28	28	24	23	27	31	29	26	32	26	30	36	30	27	40	31	11
Per cent tillable acres in:																	
Tillable pasture	17	15	17	15	19	19	24	12	17	21	23	25	16	9	12	11	15
Alfalfa hay	16	17	15	13	15	17	14	15	22	17	20	22	20	12	26	19	6
Other hay	9	5	5	14	6	8	9	3	11	15	7	9	9	5	16	30	38
Corn	15	24	20	22	17	16	10	15	13	13	12	13	15	11	8	7	0
Wheat	10	15	16	13	13	10	8	10	6	4	5	5	8	4	4	2	5
Oats (oats and barley mixed)	11	10	10	13	12	14	14	12	13	8	10	11	11	5	9	10	16
Barley	3	3	1	3	2	3	5	8	3	1	2	0	1	1	3	9	8
Beans	3	0	0	0	5	2	7	14	5	1	2	1	3	1	1	0	0
Sugar beets	1	1	0	0	1	0	3	5	0	0	0	0	0	0	0	0	0
Potatoes	2	1	1	1	1	3	0	1	1	7	7	4	4	2	6	6	1
Fruit and truck	4	1	1	1	1	2	0	1	1	1	1	3	5	40	1	1	1
Other crops	9	8	14	5	8	6	6	4	8	12	11	7	8	10	14	5	10
Crop Yields per Acre:																	
Alfalfa hay T.	1.7	2.0	1.6	1.7	2.1	2.0	2.1	2.1	1.6	1.1	1.4	1.4	1.8	1.6	1.4	1.4	1.2
Other hay T.	1.2	1.4	1.3	1.7	1.4	1.5	1.3	1.4	1.2	.8	1.1	1.0	1.2	1.4	.9	1.3	.8
Corn for silage T.	7.6	7.4	8.7	7.0	7.5	8.1	8.0	8.7	8.6	6.6	7.2	5.5	7.4	7.9	7.2	8.0	—
Corn (shelled) Bu.	36	40	35	36	37	34	38	42	34	26	36	30	32	32	31	38	—
Wheat Bu.	19	18	20	18	18	23	25	27	19	11	16	16	19	19	12	9	12
Oats Bu.	29	28	29	30	32	30	35	40	27	19	25	18	28	29	24	20	20
Barley Bu.	23	20	27	23	21	23	32	33	22	17	20	16	16	14	17	13	11
Beans Bu.	16	—	6	14	13	19	17	21	16	6	11	10	8	7	8	—	—
Sugar beets T.	8.2	7.1	—	8.8	6.4	—	7.4	9.0	—	—	—	—	—	—	—	—	—
Potatoes Bu.	125	69	115	88	79	100	137	148	110	145	138	132	105	112	131	161	165
Value crops produced per tillable acre	$14.77	$14.36	$13.98	$15.88	$13.88	$15.83	$14.45	$20.95	$13.64	$12.43	$13.54	$13.34	$15.65	—	$12.66	$15.77	$7.99
Crop sales	906	653	720	286	763	756	795	1,190	359	704	843	438	523	$2,857	460	304	355
Feed bought	313	650	479	602	345	286	273	192	141	187	194	212	342	243	97	323	293

*Tillable land in tree fruits and vineyards is not included in this factor.

Table 5. Livestock, kinds, amounts, and returns by type-of-farming areas, 1937.

Type-of-Farming Areas	All Farms	2	3	4	5	6	7	8	9	11A	11B	12AN	12AS Gen.	Comm. Fruit	13	14	Chip-pewa Macki-nac
Number of farms	1,163	89	86	45	173	63	30	119	55	89	42	46	64	124	41	77	20
Livestock Income, Total	$1,867	$3,065	$2,249	$2,568	$2,482	$2,450	$2,592	$1,877	$1,347	$1,059	$1,650	$1,381	$1,767	$844	$988	$1,377	$1,906
Livestock income per tillable acre*	18.47	23.65	16.64	29.33	19.50	21.44	18.36	17.98	14.35	11.01	13.84	15.01	20.82	17.24	12.07	25.71	14.94
Productive animal units	20.2	32.5	24.4	20.7	26.5	21.1	26.4	19.6	20.2	14.6	21.3	18.0	18.1	8.8	17.3	14.6	16.9
Tillable acres per Productive animal unit*	5.0	4.0	5.5	4.2	4.8	5.4	5.3	5.3	4.6	6.6	5.6	5.1	4.7	5.5	4.7	3.7	7.5
Cattle:																	
Number of dairy cows	9.2	9.7	9.7	11.0	9.8	12.7	14.2	8.5	8.0	7.9	10.4	9.6	9.6	4.8	8.5	10.1	9.5
Dairy sales per cow	$106	$113	$112	$128	$119	$139	$115	$100	$72	$81	$84	$87	$101	$101	$63	$107	$130
Dairy sales, total	974	1,094	1,082	1,417	1,161	1,770	1,628	853	570	640	876	834	973	485	530	1,086	1,231
Cattle income, total	1,267	1,612	1,365	1,719	1,547	2,063	2,224	1,206	859	813	1,233	1,041	1,240	596	754	1,240	1,415
Poultry:																	
Number of hens	93	143	92	228	115	76	105	111	55	46	72	49	123	64	44	49	90
Egg production per hen	144	145	130	120	150	150	136	150	153	133	150	156	149	148	128	151	162
Egg sales per hen	$2.21	$2.26	$1.86	$2.67	$2.28	$2.26	$2.23	$2.23	$1.85	$1.60	$1.99	$1.73	$2.35	$2.03	$1.58	$2.46	$3.08
Egg sales, total	205	324	172	609	263	173	233	248	102	73	144	85	289	129	70	120	277
Poultry income, total	256	413	229	714	338	218	271	305	137	104	167	121	343	166	86	125	349
Sheep:																	
Number of ewes	10	17	12	2	24	5	4	8	24	4	10	6	1	1	11	0	6
Lambs raised per 100 ewes	103	104	103	114	100	117	110	95	107	111	114	107	113	103	97	—	93
Sheep income, total	$114	$334	$136	$23	$273	$44	$50	$75	$207	$37	$104	$63	$15	$8	$96	$3	$66
Hogs:																	
Number of sows	1.1	2.7	2.4	.4	1.4	.7	.1	1.4	.8	.8	.8	1.2	1.0	.4	.7	.2	.6
Number litters farrowed	1.7	4.3	4.0	.8	2.4	1.1	.2	2.2	1.2	1.0	1.3	1.7	1.4	.7	.8	.1	1.0
Pigs weaned per litter	6.6	6.5	6.7	6.2	6.5	6.8	7.8	6.5	7.4	6.9	7.4	6.5	6.4	6.3	7.4	7.5	8.6
Hog income, total	$230	$706	$519	$113	$325	$124	$47	$291	$144	$105	$146	$155	$169	$74	$52	$9	$76

*Tillable land in tree fruits and vineyards is not included in these factors.

Table 6. Labor, machinery, and improvement costs by type-of-farming areas, 1937.

Type-of-Farming Areas	All Farms	2	3	4	5	6	7	8	9	11A	11B	12AN	12AS Gen.	Comm. Fruit	13	14	Chippewa Mackinac
Number of farms	1,163	89	86	45	173	63	30	119	55	89	42	46	64	124	41	77	20
Man Labor:																	
Number of men	1.9	1.9	1.9	1.6	1.8	1.9	1.9	1.8	1.6	1.6	1.9	1.7	1.8	2.5	1.6	1.9	1.9
Man labor cost, total	$985	$1,062	$1,014	$881	$986	$1,069	$962	$977	$728	$732	$965	$811	$919	$1,491	$759	$859	$863
Hired labor	259	349	232	193	226	280	157	228	96	111	173	199	158	779	97	96	194
Charge for family help	198	160	199	123	180	231	232	189	183	164	253	168	219	205	186	303	198
Charge for operator's labor	528	553	583	565	580	558	573	560	449	457	539	444	542	507	476	460	471
Man labor cost per tillable acre	9.46	8.20	7.50	10.06	7.74	9.27	6.81	9.36	7.75	7.60	8.10	8.82	10.61	19.34	9.27	16.02	6.76
Power and Machinery:																	
Machinery cost: Total	$298	$362	$289	$236	$305	$335	$365	$329	$216	$217	$266	$249	$244	$396	$236	$281	$286
Per tillable acre	2.87	2.79	2.14	2.69	2.40	2.90	2.59	3.14	2.30	2.26	2.23	2.70	2.82	5.13	2.88	5.25	2.24
Per cent farms using tractors	58	65	59	51	62	65	70	74	42	43	52	48	44	65	39	62	60
Number of horses	2.8	3.1	3.4	3.0	3.2	3.2	3.2	2.8	2.8	2.4	3.0	2.5	2.7	2.1	2.6	1.6	2.7
Improvements:																	
Net annual cost: Total	$131	$168	$166	$123	$178	$146	$153	$149	$96	$92	$129	$82	$109	$110	$87	$89	$101
Per tillable acre	1.26	1.29	1.22	1.40	1.40	1.27	1.08	1.43	1.02	.95	1.08	.89	1.26	1.43	1.07	1.66	.79
Investment per animal unit	144	122	141	142	148	160	131	181	103	117	138	106	134	307	94	142	145
Feed bought per tillable acre	3.00	5.00	3.55	6.88	2.71	2.48	1.93	1.84	1.50	1.94	1.62	2.30	3.95	3.15	1.18	6.04	2.30
Crop expense per tillable acre	2.10	1.83	1.71	1.75	1.85	1.98	1.75	2.33	1.11	1.31	1.15	1.31	1.58	6.58	1.11	2.09	.89
Taxes per tillable acre	.68	.74	.70	.73	.63	.82	.62	.74	.58	.45	.64	.56	.66	.96	.50	.69	.48
Other expenses per tillable acre	.55	.59	.50	.76	.54	.85	.44	.57	.33	.37	.60	.51	.54	.76	.27	.98	.31
Gross income per tillable acre	$26.51	$26.24	$23.40	$32.75	$24.61	$26.13	$24.48	$29.48	$20.11	$15.93	$18.92	$19.54	$26.04	$51.34	$18.23	$34.86	$19.05
Total expenses per tillable acre	19.92	20.44	17.32	24.27	17.27	19.57	15.22	19.41	14.59	14.88	15.42	17.09	21.42	37.35	16.28	32.73	13.77
Net income per tillable acre	6.59	5.80	6.08	8.48	7.34	6.56	9.26	10.07	5.52	1.05	3.50	2.45	4.62	13.99	1.95	2.13	5.28
Expenses Per $100 Income	75	78	74	74	70	75	62	66	73	93	82	87	82	73	89	94	72

combined with the actual expenditure for hired labor accounts for 47 per cent of the total expenses. The figures are averages and of course much variation is found between individual farms.

State and Area Averages

The accompanying tables, 3, 4, 5 and 6, indicate that farm earnings in any one year vary considerably between different areas, and do not retain the same relative position in earnings year after year. (See bottom of Table 3.) Factors beyond a farmer's control, such as weather conditions and changes in the price level for the products produced, may cause changes in the relative position. These tables show percentages of tillable land in various crops, crop yields, livestock inventories, power and machinery costs, amounts of labor, and various factors affecting farm earnings, as well as average incomes and expenses.

SUPERB GOLDEN

A NEW HYBRID MUSKMELON

C. H. MAHONEY
Section of Horticulture

History of Superb Golden

The parents of Superb Golden were Emerald Gem and Honey Dew. Emerald Gem is a small, ribbed, dark green shelled, partially netted fruit with thick orange flesh. Honey Dew has medium-sized, non-ribbed (smooth), yellow-shelled, non-netted fruit with thick, crisp, green flesh. The original cross was made by George Starr of the Michigan Agricultural Experiment Station in 1930. The breeding work was undertaken by the author in 1931.

The fruits in the first generation either had dark green shells or greenish-yellow shells and all were ribbed; were fairly well covered with a fine net; and the majority of plants produced green-fleshed fruits. Some plants produced fruits with the placental region and the inner flesh showing a distinct "pink" or orange color with the outer one-half inch a light green. A number of the different F_1 types were selfed. With the exception of 1932 when open-pollinated fruits were selected, each generation has come from fruits self-pollinated by hand under glassine bags. Each year progenies of 25 to 30 hills were grown for field notes and observation and for further self-pollination.

Twenty per cent of the plants in the second generation produced yellow-shelled fruits which were ribbed, not netted or had slight flecks of net, and 1/7 of these had thick orange flesh, the remainder having thick green flesh. The yellow fruited plants were self-pollinated and in the following generation, plant selections having deep orange flesh and yellow shell were inbred. In the fourth generation the yellow shell and orange flesh characters were fairly uniform but the plants were still segregating for deep and shallow ribs. After two additional generations of selfing, six sib-progenies in the sixth generation were prac-

tically identical for such characters as shell color, flesh color, ribbing, size and shape of fruit, and thickness of flesh. Careful measurements were made of the size of fruit and thickness of flesh, and statistical analyses showed that these two characters were fairly uniform.

Description of Melon Type

The vine growth is extremely vigorous, leaves are large, and fruiting branches are heavy. Growth is more vigorous and heavy than that of Honey Rock, Hearts of Gold, or Honey Dew.

This is a mid-season variety which reaches picking stage about two to four days later than Honey Rock and in season with Hearts of Gold. This variety has a slightly higher heat-unit requirement than Honey Rock. When nights are cool during mid-summer this variety will mature 4 to 6 days later than Honey Rock but in Michigan during warm summers it reaches maturity at approximately the same time.

Statistical measurements and notes on three sixth generation sibs are given in Table 1 to illustrate the uniformity obtained with this new variety.

Table 1. Type measurements on three F_6 sib-progenies.

Prog. No.	Fruit Shape		Trans. Dia. Fruit		Flesh Thickness		Color of Flesh	
	Mode	Range	Mean	Range	Mean	Range	Mode	Range
3075..........	R	R	4.98	4.6 to 5.5	1.5	1.4 to 1.6	Deep Sal. orange	—
3076..........	R	R to OR	4.95	4.4 to 5.4	1.5	1.4 to 1.6	Deep Sal. orange	—
3077..........	R	R to OR	4.94	4.4 to 5.5	1.5	1.3 to 1.6	Deep Sal. orange	—

Fruit—Medium in size, 5 to 6 inches in transverse diameter. Shape round to slightly oblong-round not flattened at base and apex, blossom scar rather conspicuous; ribs moderately prominent 1¾-2 inches at medial; sutures narrow, shallow and an olive green until shortly before maturity, then turning yellow. Not netted; occasional flecks of cork scattered over ribs. Shell color greenish-yellow turning to brilliant yellow at maturity (Plate 19C-1*). Flesh deep salmon-orange, (Plate 10, D-7 to H-7*), very thick 1½-2 inches, texture fine to coarse, firm and moderately juicy; very sweet on after-ripening, total solids high; quality excellent. Cavity small 1¼-1¾ inches, circular. Rind thick and rather soft when fully matured.

Harvesting and Storage

This variety requires a short period of "after-ripening" before it reaches its maximum of quality. The fruits should be picked before the shell begins to soften or shortly after the "three-quarters slip."

*Maerz, A and M. R. Paul. Dictionary of Color. McGraw-Hill Book Co., New York, N. Y.

Fig. 1. Cross section and entire melon of Superb Golden.

There is a distinct change in color from a light greenish-yellow to a bright yellow and fruits should be picked at this time. They will crack badly if left in the field beyond this stage. The melons should be stored at a temperature of 70 to 75 degrees F. for several days to increase the sugar content and "blend" the aromatic cantaloupe flavor with that of the Honey Dew. **Fruit should not be marketed directly from the field; without this period of "after-ripening" the flesh is hard, dry, crisp, and lacks flavor.** This variety can be placed in cold storage for a period of a week to 10 days after receiving two days of "after-ripening" at 70 degrees F.

The introduction of this new variety is not for the purpose of replacing any of the standard commercial sorts such as Hearts of Gold or Honey Rock, but to supplement them with an early Honey Dew type which can be grown in the north. The dry, crisp, sweet flesh of the Honey Dew combined with the aromatic flavor of the muskmelon is far more attractive to the average northern consumer than that of the typical Honey Dew. The ribbed segregate was chosen by commercial growers as they felt that this yellow-ribbed type would be a trademark to distinguish this melon from the green-fleshed western Honey Dew. It should find a place in commercial production especially where the crop is marketed locally or from roadside stands.

Seed

Small samples of seed will be available this winter to **commercial cantaloupe seedsmen only** for increase in 1939. There will be no general release of seed, since the supply of hand pollinated seed is necessarily limited.

DISTRIBUTION OF FLAVORS IN MILK AT THE RECEIVING PLATFORM

G. M. TROUT
SECTION OF DAIRY HUSBANDRY

Flavor studies were made on 920 cans of milk at the receiving platform of a local dairy during the late summer of 1937. In studying the flavor and odor of milk from the individual cans, two objectives were in mind: (1) to note the distribution of flavors in the raw product at that season and, (2) to note if all the milk of a single producer had the same flavor. Such information would be of material value in guiding the production of milk from the standpoint of flavor quality.

The data obtained were the basis in part of a discussion on off-flavors in raw and in pasteurized milk made at the Laboratory Section meetings of the Thirtieth Annual Convention of the International Association of Milk Dealers and are included in their Proceedings.* Sufficient interest was manifest that it seemed desirable to make the data more available to Michigan dairymen through the Quarterly Bulletin.

Table 1. The flavors of milk at the receiving platform as observed in individual cans.

Flavor	Number of Cans	Percentage distribution (%)
Clean, pleasant	413	44.89
Feed	219	23.80
Musty	101	10.97
High-acid	73	7.93
Unclean	58	6.30
Barny	13	1.41
Cowy	12	1.30
Oily	13	1.41
Miscellaneous	18	1.95
Totals	920	99.96

The nature of the flavors noted in these studies and their distribution are presented in Tables 1 and 2. As noted in Table 1, approximately 45 per cent of the cans of milk examined were classified as having a clean, pleasant flavor. The remaining 55 per cent of the cans of milk in which off-flavors were noted are reclassified and the distributions included in Table 2. Of the off-flavors noted, feed flavors were the most predominant, amounting to 23.8 per cent of all the samples and to 43.19 per cent of the off-flavored samples. Musty flavor was second to feedy flavor in occurrence, followed closely by high-acid flavors.

*Trout, G. M. Off-flavors in Raw and in Pasteurized Milk. Proc. 30th Ann. Conv. Int. Assn. Milk Dealers, Lab. Sect., p. 131-142, 1937.

Table 2. The flavors of milk at the receiving platform as observed in individual cans.

Flavor	Number of Cans	Percentage distribution (%)
Feed	219	43.19
Musty	101	19.92
High-acid	73	14.37
Unclean	58	11.44
Barny	13	2.56
Cowy	12	2.37
Oily	13	2.56
Miscellaneous	18	3.55
Totals	507	99.98

Considering the season of the year, late August, when much pasturing of alfalfa was practiced and when the nights were warm, it is not surprising to find such a high percentage of feed flavors and of high-acid flavors present. Other flavors such as unclean, "barny", "cowy", oily and miscellaneous were noted, but contributed only a small percentage to the off-flavored samples as a whole.

Examination of the milk from the individual cans rather than the mixed milk from the weigh tank gave a clue to the method of production not to be noted in the examination of the mixed milk as a whole. For example, in flavoring, by the individual can method, the milk of a four- to six-can producer, it was common to find half the cans severely criticised for off-flavors while the other half were free of undesirable flavors. This was particularly true of such flavors as feed and high-acid. The predominating feed flavor was from alfalfa pasturage. The lack of this flavor in some cans of a single producer yet present in others, was doubtless the result of management. The cows evidently were kept off the pasture several hours before milking in one case and milked immediately from pasture in the other case. Hence, the difference in flavor between the night's and morning's milk.

The same may be said of the high-acid milk as well. Inadequate cooling of the night's milk and prompt delivery of the morning's milk yielded half the cans with a high-acid flavor in the one half and the other half free of this flavor defect. Yet as a result of blending, the specific defect may not be noted in the mixed milk.

A significant observation was made on the "musty" flavor. When this flavor was encountered it usually was present throughout the entire lot of milk, rather than in a part of the cans. This defect is easy to recognize but extremely difficult to diagnose. It may be the result of inadequate or delayed cooling; to poorly washed cans; to uncleanliness or to a combination of those causes. Frequently this flavor in lesser intensity is called "smothered" which would seem to be questionable. In the more intense form the flavor is sometimes called "fishy", or "dishcloth".

The "barny" and "cowy" flavors, which are usually more common during the winter season than during the summer, are often difficult to distinguish from each other. The former seems to have an associated uncleanliness lacking in the latter.

The oily flavor found in these studies was suggestive of kerosene and of exhaust fumes, probably absorbed from the engine operating the milking machine.

The flavor of milk delivered at the receiving platform is not constant for each producer throughout the year but varies with the season, feed, temperature, and period of lactation. The examination of milk flavors at one season of the year may not be indicative of the flavors at other seasons. Likewise, the flavor of milk in the weigh tank may not be indicative of that of the several cans of a single producer which make up the whole.

Change in management of feeding practices together with adequate cooling would eliminate much of the feed, musty and high-acid flavors predominating the off-flavors at certain seasons of the year.

CONTROLLING INSECTS ON RASPBERRIES

RAY HUTSON
SECTION OF ENTOMOLOGY

Raspberries are a popular and profitable small fruit affected by a number of insects well known to entomologists. However, the abundance and kinds of these pests vary so much from year to year that predictions are difficult, and control measures commonly employed require revision to harmonize with present knowledge and regulations. As an example of the necessity for revision, the outbreak of raspberry sawflies last spring found many growers using arsenicals on raspberries with a crop already set. The danger of residues can be avoided by use of present knowledge; in controlling sawflies, rotenone-containing and pyrethrum insecticides seem more effective than arsenicals.

For convenience of discussion, the insects infesting raspberries may be divided into those affecting the foliage, the cane and the fruit.

Insects Affecting the Canes

The most important insects infesting the canes are the red-necked cane-borer, *Agrilus ruficollis;* raspberry cane girdler, *Obcrea bimaculata,* and rose

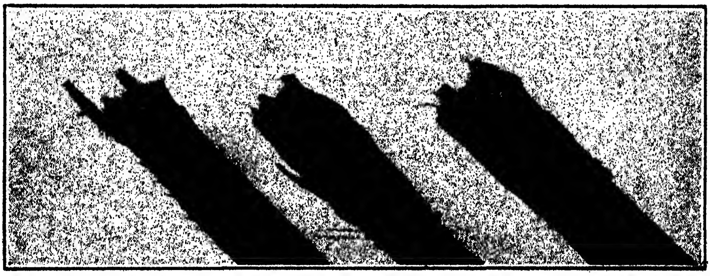

Fig. 1. Raspberry canes infested by cane borers often break over at the point girdled by the larvae.

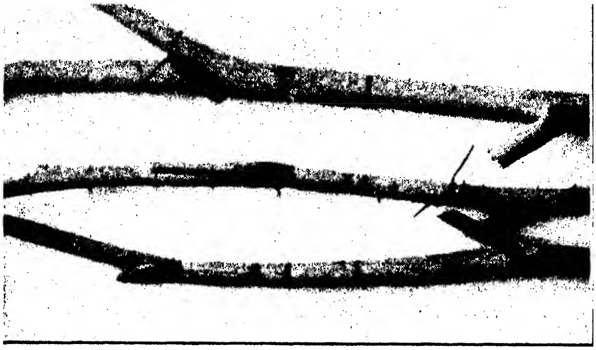

Fig. 2. Injury inflicted at egg laying and adult Raspberry cane borer.

girdler, *Agrilus communis* var. *rubicola.* The crown borer, *Bembecia marginata,* and tree crickets, *Oecanthus,* sometimes cause difficulty in plantings of raspberries, but ordinarily in well-cared-for plantings pruning takes care of the tree crickets while, as yet, the crown borer is very largely a curiosity in Michigan plantings. All of these insects in the adult stage are rather inconspicuous, but individuals are capable of doing damage out of proportion to their size by depositing eggs. For that reason, no great amount of space needs to be spent on the appearance of the adult insects. Injury by the red-necked cane borer and by the rose cane borer results in the formation of swollen areas about the canes, usually within one foot of the ground. These swellings are caused by the activity of the larvae of these borers, which are small, worm-like inconspicuous forms, deriving their food from the cambium or growing layer of the cane. Very commonly, activities of these larvae bring about a weakening of the canes at the point where the gall is formed with the result that large numbers of canes break over. These same swellings can be observed on dewberries, blackberries, and on rosebushes. In case the canes do not break over, they are weakened and may die and, in any case, will not bear a normal crop. The only habit of the adult beetles that needs to be noticed is that they feed upon the foliage of the raspberries prior to depositing the eggs, eating holes and giving the leaves a generally ragged appearance. It is doubtful whether the feeding by the adults on the leaves is of any particular consequence, although in heavy infestations, this habit affords an additional means of combating the insects since an application of arsenical applied just prior to blooming aids in control. Ordinarily this method does not need to be used and is mentioned solely for use in case of heavy infestations.

Tree crickets, while not so destructive as the cane borers, may under local conditions build up to a point where they are capable of causing considerable loss. This is especially true under conditions where heavy pruning is not regularly done. Tree cricket adults, as their name indicates, somewhat resemble crickets in form of the body. However, they are of a yellowish or greenish-white color and are often noticed by growers. The damage by tree crickets consists in the deposition

of eggs in long rows in the canes while they are young and succulent. Later, when the canes ripen, this causes them to split and break over. Ordinarily the pruning operations followed in a planting of raspberries take care of this insect inasmuch as it has but a one-year cycle. Little trouble is experienced in Michigan since the regular pruning practice largely controls the insect.

Crown borer, fortunately, has not caused any large loss of Michigan raspberries in recent years. This insect is the larva of a moth which deposits its eggs near the ground level sometime during late August and September. The immature stages of the insects are completed within the cane at the ground level and the adult emerges again the following summer. No control measures have as yet been necessary for this insect in this state and it is included in this discussion solely for the sake of completeness.

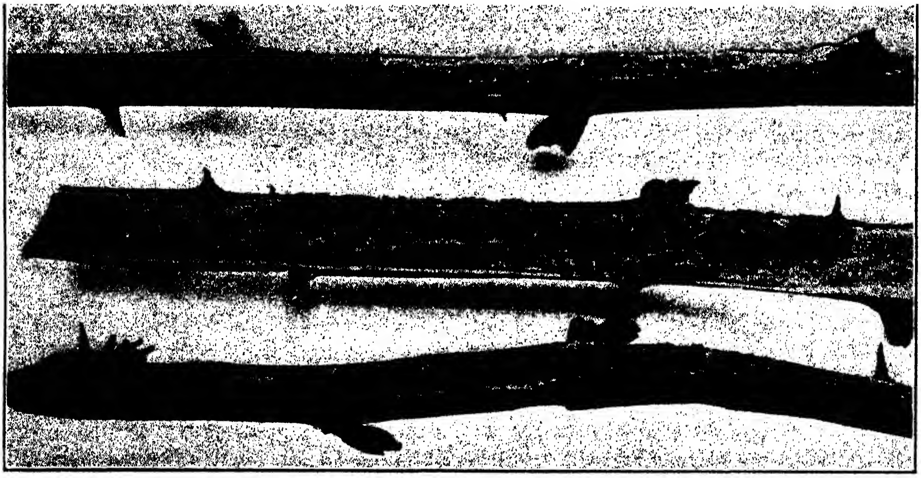

Fig. 3. Tree cricket eggs cause the canes to split or break.

Insects Affecting Foliage

A great many foliage-feeding insects, such as caterpillars, may be found upon the foliage of raspberry; however, most of them will succumb to the treatment that is applied for sawfly, which is the most important foliage-feeding pest of the raspberry. As in the case of the insects infesting the canes, the sawfly adults are not very conspicuous but belong to the same general group as wasps and are probably mistaken for them when seen by the grower. The larvae, however, are small, worm-like insects, mossy green in color, which are familiar to every raspberry grower. There is commonly one generation and sometimes two in a season. The feeding of these larvae gives the foliage a ragged, shot-holed effect, and when the larvae become numerous and are allowed to feed undisturbed the foliage may be entirely destroyed. The attack of sawflies, coming as it does commonly about time that the berries are ripening, has a most adverse effect upon

the crop. There seems to be little chance of predicting when they will appear in any given locality; consequently, treatment for the insects should be deferred until they are seen at work. Sawflies are readily controlled by rotenone-containing or pyrethrum sprays and dusts. There are a number of good materials on the market, and the manufacture of these materials has become so standardized that purchase of a ready made dust is the best way to obtain the materials. The application of about 15 pounds of a dust containing ¾ of 1 per cent rotenone has given very good control against this insect. Equally good results have been obtained by applications of 15 pounds of a pyrethrum dust containing approximately 0.2 of 1 per cent pyrethrins. The only caution that needs to be emphasized is that sulphur should not be used as a diluent for dusts applied to raspberries. Equally good results in the control of these insects have been obtained by the use of sprays of derris and pyrethrum, although it seems that dusts of these materials are more available than sprays in many raspberry-growing districts. Should the insects appear prior to fruit setting, arsenical sprays or dusts may be used.

Fig. 4. Raspberry leaves skeletonized by sawfly.

Mites often cause much difficulty by feeding upon the foliage of raspberries. Mite feeding consists in the withdrawal of sap from the leaves with the result that they attain a scorched appearance and then, if the population of mites continues to increase, the leaves fall off. Mite attack is very severe since the period of greatest abundance of mites seems to come just at the time when the berries are ripening. In cases where mites become very abundant, plants attacked by them may present a scorched appearance and crop loss result. Mites are not insects but are closely related to them. The particular mites that are most commonly found on raspberries seemingly over-winter upon the canes. Hence, a dormant spray of liquid lime-sulphur or of 2-per cent oil constitutes a very good means of fighting them. In applying dormant sprays for mites, care should be taken to make sure that the sprays are applied during the time when the canes are completely dormant, else injury may result, especially to red raspberries. Many growers prefer to wait until the leaves are out and then fight the mites. A large amount of spraying has been done in this connection, and it seems that the best spray for combating mites is a 1-per

cent oil spray applied at the rate of about one gallon per rod of row and repeated three times at weekly intervals. This spray can be put on at any time and constitutes an excellent means of control without danger of residue. During the last two years success in the control of mites on raspberries has followed the use of a spray of bill-poster's paste at the rate of 5 pounds in 100 gallons of water. Here, again, the spray must be repeated and here, also, there is no danger of residue.

Raspberry fruit worm, *Byturus unicolor,* is an occasional pest of raspberries which at times becomes very numerous. The adult is a small brown beetle which appears about the time that the raspberry fruit buds appear and feeds upon the leaves. It is the habit of the adult beetle to deposit the egg in the bud of the raspberry where it grows and comes to maturity about the time the raspberries are picked with the result that the fruits are "wormy." As already noted, the adult insect feeds upon the foliage of the plant, hence, an application of a dust or spray to the foliage prior to the time when the blooms appear will result in control of this insect. Very good results have attended the use of calcium arsenate dust made up in the proportions of one part of the arsenate to nine parts of lime. If the presence of these insects is not noted in the planting until the plants are in bloom, or nearly so, the insect may be controlled through the use of a derris dust, such as has been described for use against sawfly.

As has already been indicated, the insects discussed are not all of those which may be found from time to time on raspberries. However, these are the most important and their control can be stated in the form of an insect control summary for raspberries with the assurance that with very slight modifications the summary will fit conditions anywhere in the state.

The foregoing summary is submitted as a reminder. Many growers

SUMMARY OF INSECT CONTROL ON RASPBERRIES

Treatment	Method or Material	Insect Controlled
Dormant	Prune and burn all malformed and old canes.	Red-necked cane borer. Raspberry cane girdler tree crickets.
	Liquid lime-sulphur, 10 gallons in 100; or 2% dormant oil.	Mites.
Just after leaves appear	1% summer oil—repeat three times at three-day intervals.	Mites.
Just before bloom	Lead arsenate 3 pounds; in 100 gallons, or calcium arsenate—Lime 1–10.	Sawflies and leaf feeders. American Raspberry beetle.
After fruit is set	Always use non-arsenical sprays or dusts.	Mites—1% summer oil. Sawflies and other leaf feeding insects.

need make only a few of these applications, the chief thing being to remember that all of these insects have a tendency to appear year after year in the same plantings after they are once established unless something is done.

Another point readily apparent is that applications prior to fruit setting take care of true insects affecting foliage and aid in controlling cane borers. In fact, an application of arsenical just prior to blooming is the most important spray for all chewing insects.

BULLETIN REVIEWS

Cir. Bul. 166—Water Conditioning for Greenhouses.—Spurway, C. H. and Wildon, C. E.—Description and explanation is given of a device that is connected with the water main and through which all of the water flows that neutralizes the alkalinity of "hard" water with phosphoric acid. It can be adjusted to deliver water of various degrees of alkalinity or acidity. Data are given on the influence of "conditioned" as compared with "hard" water on certain greenhouse crops. (10 pp., 1 table, 2 figs.)

Cir. Bul. 167—Controlling Rats and House Mice.—Hayne, D. W. and Jefferson, C. H.—A discussion of different methods of combating rats and mice about buildings. Part I contains an account of the history and habits of rats and the types of damage done, as well as an explanation of the various recommended control measures, which are: preventing rats from obtaining food, poisoning, fumigation, blocking, trapping, and other methods. Part II is devoted to the only permanent solution, rat-proof construction. (32 pp., 14 figs.)

Spec. Bul. 294—Profitable Poultry Production.—Wright, K. T.—Flocks in this cost of production study had an average production of 114 eggs per hen based on the number of birds at the start of the year, or 157 eggs based on the average number of hens. Of 100 birds at the start, 19 died, 42 were culled out and 39 were left, resulting in an average of 73 birds for the year.

Feed consumption averaged 40 pounds of mash and 39 pounds of scratch per hen for the year, valued at 52 per cent of the $2.34 total cost per hen for the year. Depreciation comprised 18 per cent of the total cost, labor made up 13 per cent, buildings and equipment use 7 per cent and other items 10 per cent. Income totaled $2.66 a hen, leaving a net return of 32 cents. The return to these better-than-average poultrymen was 37 cents an hour, or approximately twice the rate paid hired help.

The most important factors affecting net returns were: (1) eggs laid per hen, (2) fall egg production, (3) feeding efficiency, (4) death loss and culling percentage, and (5) labor efficiency. The men scoring the lowest on these factors lost 21 cents a hen, while those ranking the highest made a net return of 86 cents a hen.

To feed the broilers and pullets of 100 baby chicks required 703 pounds of mash and 318 pounds of scratch, which had a value of $18.08 during the period of this study. The cost of the chicks, feed, labor and all other items totaled $38.41 on 100 chicks. Income, other than pullets, amounted to $16.02, leaving a net cost of $22.39 for the pullets, or 58 cents each. Feed consumption averaged 4.9 pounds per pound of poultry produced, thus 1.8 pound broilers ate 8.9 pounds of feed, and 3.5 pound pullets 17.0 pounds of mash and scratch.

Feeding efficiency of the poultrymen and breed of poultry were important factors influencing pullet cost. Mortality in raising the chicks

had more effect on the laying flock returns than pullet cost, within reasonable limits. Hatching date of the chicks likewise had more influence on profits of the laying flock than on pullet cost. Thus, low mortality in the chicks was necessary for profits on the hens, and the slight increase in the net cost of early pullets was more than balanced by the higher egg income. (52 pp., 34 tables, 18 figs.)

Spec. Bul. 295—The Michelite Bean.—Thayer, J. W. and Down, E. E. —Michelite is the name given to a new variety of white navy bean developed by the Michigan Agricultural Experiment Station and first released to Michigan farmers for commercial production in 1937. The Michelite bean is a segregate selected from a cross between Early Prolific, a white bean of unusually good quality, and Robust, a high-yielding, disease-resistant, white navy bean previously developed at this station and, at present, the most commonly grown bean variety in Michigan.

Under Michigan conditions, the Michelite bean carries the resistance to mosaic, resistance to field infection of bacterial blight or wilt, and the vigor and productivity of its Robust parent. It is an improvement over the Robust bean in quality because of its uniformity in size and shape and its glossy white seed coat, characteristics inherited from the Early Prolific variety. It blooms from two to four days earlier but frequently ripens no earlier than does Robust. Because the Michelite bean generally has a lower percentage of culls than the Robust and, consequently, a higher percentage of marketable beans, because it yields as well as Robust and is superior in quality and appearance, this new variety should prove profitable for the Michigan bean industry. (23 pp., 8 tables, 6 figs.)

Spec. Bul. 296—Fertilizers for White Pea Beans.—Millar, C. E., Cook, R. L., and Davis, J. F.—Fertilizer experiments with white pea beans were conducted each year from 1923 to 1937 inclusive and on two farms in 1921. During this period experiments were located on 57 farms in 18 counties, and on 10 different soil series. The results of these experiments as presented in the bulletin lead to the following conclusions:

1. Broadcast application of fertilizer resulted in no increases in yield or in increases which, in most cases, were too small to pay for the fertilizer applied.

2. Seventy-five pounds of fertilizer applied with the seed failed to increase yields and furthermore decreased stand.

3. Three hundred pounds of 4-16-4 fertilizer in bands near the seed, but not in contact with it, caused significant increases in yield which in many cases were sufficient to more than pay for the fertilizer.

4. The advantages of fertilization may be nullified by adverse weather conditions especially at blossom time, even though early growth has been increased.

5. Fertilizer placed in a band about 1½ inches below the seed, or in bands 1½ inches to the side and deeper than the seed gave better results than other placements tried. A band of fertilizer on one side of the seed was as satisfactory as bands on both sides.

6. As a whole, a 0-16-8 fertilizer gave better results both from the standpoint of yield and economy than did 0-16-0 or 4-16-8.

7. Increases in yield resulting from application of fertilizer were not as consistent or as great as could be desired, largely because of the sensitivity of the crop to adverse weather conditions. The results of the work indicate that building up of the soil with manure, green manure, and fertilizer in the years preceding the planting of beans may be more advantageous than applying fertilizer at the time of planting the crop. (45 pp., 27 tables, 9 figs.)

Tech. Bul. 161—Studies in the Nature of the Pomological Variety. I. A Hetero-chimeric Apple Sport and Its Vegetative Progeny.—Gardner, V. R.—An historical and descriptive account is given of an unusual apple tree sport that is classified as a periclinal chimera, from which a number of distinct types have been segregated. Certain resemblances between this sport and a number of standard pomological varieties are pointed out. (14 pp., 2 tables, 4 plates.)

JOURNAL ARTICLE ABSTRACTS

Taxonomic Notes on the Dipterous Family Chloropidae.—Sabrosky, Curtis W.—Jour. New York Entomological Society. 46(4):417-434. 1938. (Journal Article No. 293 (n.s.) from the Mich. Agr. Exp. Sta.)—Certain miscellaneous notes accumulated during the study of the classification of this group of small flies have been collected and published under the above title. Two new species are described, two new names are proposed, five new synonyms are established, and keys are given for the separation of species of two distinct groups within the family.

Quantity and Relationships of Certain Elements in Michigan Legume Hays.—Millar, C. E.—Jour. Am. Soc. Agron. 30(6):507-513. 1938. (Journal Article No. 301, (n.s.) from the Mich. Agr. Exp. Sta.)—Samples of alfalfa, clover and sweet clover were collected from plats variously fertilized on different soil types during a period of 13 years. A study of the data derived from analyzing the samples lead to the following observations:

1. The nitrogen and phosphorus contents of the plants correlated closely.
2. Nitrogen-potassium, potassium-phosphorus, magnesium-phosphorus, and magnesium-nitrogen contents showed positive relationships.
3. Calcium-phosphorus, nitrogen-calcium, calcium-magnesium and calcium-potassium contents showed inverse relationships.
4. The phosphorus content of alfalfa grown on heavy soil types was higher than that of alfalfa grown on light soils. Applications of superphosphate under field conditions did not increase the phosphorus content of the hay, although there was a slight tendency for the phosphorus content of the leaves of alfalfa grown on sandy soils to be increased. Under greenhouse conditions, the phosphorus content of alfalfa was appreciably increased through very large applications of superphosphate.
5. Under field conditions applications of limestone reduced the phosphorus content of alfalfa, and applications of potash tended to increase it.
6. Applications of superphosphate increased the phosphorus content of field-grown red clover and sweet clover.

A Comparative Study of Methods of Determining the Moisture Content of Cheddar Cheese. II. The Steam Oven Method at High Pressure and the Olive Oil Methods.—(Gould, I. A.—Jour. Dairy Sci 21 (7) :379-383. 1938. (Journal Article No. 308 (n.s.) from the Mich. Agr. Exp. Sta.)—Analysis of cheddar cheese was made by the steam pressure oven operated at approximately 85 pounds pressure, the olive oil method in which the cheese was suspended in olive oil and dried directly over a flame, and the modified olive oil method which consisted in adding salt to the olive oil prior to the heat treatment to prevent sticking and spattering of the cheese during heating. Twenty-eight of 31 trials gave higher results by the steam oven than by the olive oil procedure, with the average difference being approximately 0.3 per cent. The

average difference between duplicate determinations by the oven method averaged 0.19±.02 per cent. The modified oil method gave results averaging within 0.1 per cent of those secured by the oven procedure. In general, the oil methods appear to be sufficiently accurate for all practical purposes and possess the distinct advantage of being more rapid than the oven procedure.

Cardiovascular and Other Lesions in Calves Fed Diets Low in Magnesium.—Moore, L. A., Hallman, E. T. and Sholl, L. B.—Archives of Pathology. 26:820-838. 1938. (Journal Article No. 314 (n.s.) from the Mich. Agr. Exp. Sta.)—Calves fed rations low in magnesium to the extent that the blood magnesium was reduced to a low level exhibited a definite pathologic picture. The principal pathologic alteration consisted of a deposition of calcium salts in the yellow elastic fibers of the endocardium, of the aorta, jugular vein and larger arteries, of the surfaces of the diaphragm and of the trabeculae and capsule of the spleen. Also notable were degeneration and calcification of Purkinje fibers. There were present also various degrees of hepatitis and nephritis. A possible relationship of diets low in magnesium to the arteriosclerosis of human beings is suggested.

Comparative Tests of Fixed Nicotines and Lead Arsenate Against Codling Moth.—Hutson, R., Merritt, J. M. and Parmelee, F.—Jour. Econ. Entom. 31(3):374-377. 1938. (Journal Article No. 318 (n.s.) from the Mich. Agr. Exp. Sta.)—Fixed nicotines and combinations of fixed nicotines with other materials tested in replicated plots of McIntosh, Duchess, Northern Spy and Baldwin apples in 1936 and 1937 gave control under conditions of heavy infestation, (50 to 200 worms per 100 apples in unsprayed plots), which compared favorably with applications of lead arsenate, 3 pounds to 100 gallons, applied as a check. The fixed nicotines are increased in effectiveness by the inclusion of oils. This is especially true in the combination of Black Leaf 155 plus 2 quarts of summer oil emulsion. In addition to the control secured, observations upon the tolerance of apple trees to the fixed nicotines showed them to be remarkably free from injurious effects.

A Field Outfit for Determining the Moisture Content of Soils.—Bouyoucos, G. J.—Soil Science. 46:107-112. 1938. (Journal Article No. 321 (n.s.) from the Mich. Agr. Exp. Sta.)—An outfit is described which can easily be carried into the field for the accurate and rapid determination of the moisture content of soils by means of the alcohol method.

Studies on the Composition of Bovine Blood. I. The Magnesium Content of the Blood Plasma of the Normal Dairy Calf.—Duncan, C. W., Lightfoot, C. C., and Huffman, C. F.—Jour. Dairy Sci., 21(11):689-696. 1938. (Journal Article No. 322 (n.s.) from the Mich. Agr. Exp. Sta.)—In order to establish certain basic facts concerning the amounts of magnesium in the blood plasma of growing dairy calves, 2,286 values were obtained from 107 normal calves at intervals of one or two weeks for a period of three years. Mean values were calculated for each month for the first 18 months of life. There was a definite tendency for the concentration of magnesium to increase up to 12-13 months and

the change in level was accompanied by a series of rhythmic variations. The mean of all of the determinations was 2.414±.005 mg. per 100 cc. of blood plasma (range 1.62 to 3.83 mg.) and 79.7 per cent of the values were between 1.895 and 2.795 mg. Seventy-two and one-half per cent of all the values occurred within the limits of plus or minus one standard error of prediction ($O_e = \pm 0.374$).

From the results obtained from this investigation it must be concluded that the concentration of magnesium in the growing dairy calf cannot be regarded as constant. The range of the so-called normal variation is sufficiently wide to include many variations that occur under pathological conditions since the maximum and minimum values for each month were definitely outside of the limits of plus or minus one standard error of prediction. The results also make it evident that fluctuations in the plasma magnesium content of the blood of dairy calves are to be expected as normal occurrences.

A Mechanical Device for Determining the Permanent Wilting Point of Soils by Means of the Cohesion Method.—Bouyoucos, G. J.—Soil Science. 46:331-336. 1938. (Journal Article No. 324 (n.s.) of the Michigan Agricultural Experiment Station)—An automatic device is described which increases the convenience, accuracy, and reliability of the cohesion method for determining the wilting point of soils.

The Effect of Fertilizer on the Length of Winter Wheat Heads.—Cook, R. L. and Baten, W. D.—Jour. Amer. Soc. Agron. 30:735-742. 1938. (Journal Article No. 328 (n.s.) of the Mich. Agr. Exp. Sta.)—The effect of fertilizers on the length of winter wheat heads was determined by measuring large numbers of heads taken from field plats in 1935, 1936, and 1937. The significance of mean differences is shown by analysis of variance. The use of Shepherd's correction for grouped data is illustrated. A statistical study of the number of heads necessary to make a representative sample is included.

The unfertilized wheat produced larger heads in 1935 and shorter heads in 1936 than did the fertilized wheat. During both years, fertilizers greatly increased the number of heads per foot of row. As the stand of the unfertilized wheat was much thinner in 1936 than in 1935 it is concluded that when crowding is not a factor, fertilizers may be expected to increase the length of heads but when the stand is so thick that the greater number of heads as a result of the fertilizer causes crowding, the length of the heads may be decreased. Some fertilizers resulted in larger heads than did other fertilizers.

The use of Shepherd's correction for grouped data did not change the interpretation placed on results.

The data obtained from the measurements showed that 100 heads picked at random did not truly represent the entire population but that it was necessary to measure 700 heads to obtain significant differences which were approximately the same as when all the heads were measured. The number "700" was theoretically checked by calculating "N" from the formula for "T".

Quantitative Studies of Brucella Precipitin Systems. I. Precipitation of Homologous Antisera by Brucella Endoantigens.—Pennell, R. B. and Huddleson, I. F.—Jour. Exp. Medicine. 68(1):73-81. 1938. (Journal Article No. 329 (n.s.) from the Mich. Agr. Exp. Sta.)—It has been shown

that the precipitation by the endoantigens of the three species of *Brucella* of their homologous antibodies may be described by equations developed from the law of mass action. The endoantigens may be used for the accurate calibration of *Brucella* antisera. The nitrogen-containing constituent of the endoantigens does not always seem to be intimately connected with the ability to precipitate the specific anti-bodies.

Quantitative Studies of Brucella Precipitin Systems. II. The Precipitation of Heterologous Antisera by Brucella Endoantigens.—Pennell, R. B. and Huddleson, I. F.—Jour. Exp. Medicine. 68(1):83-93. 1938. (Journal Article No. 330 (n.s.) from the Mich. Agr. Exp. Sta.)—Quantitative cross precipitation studies with goat antisera show the three endoantigens of the *Brucella* to be serologically distinguishable. Although the endoantigens of *Br. abortus* and *Br. suis* are very similar, they do not react identically, permitting the serological distinction of the two organisms. These differences in cross precipitation may be used to identify an organism of the *Brucella* group or to determine the organism responsible for a *Brucella* antiserum.

The Relation Between the Presence of Brucella Abortus and Agglutinins in Milk in Cattle Showing a Blood Agglutination Titer of 1-200 or Higher.—Myer, D. B. and Huddleson, I. F.—Cornell Veterinarian. 28(4):293-295. 1938. (Journal Article No. 332 (n.s.) from the Mich. Agr. Exp. Sta.)—In the majority of the animals studied *Br. abortus* appears in the milk before agglutinins are detected in the milk. *Br. abortus* may be present in the udder for a long period without the presence of agglutinins. *Br. abortus* and agglutinins may occasionally be present in the udder in the absence of agglutinins in the blood. Approximately 12 per cent of animals showing agglutinins in the milk in a titer of 1:100 or higher and positive milk culture become negative to the former or the latter or to both. These data show that often times there is little, if any, correlation between the presence of *Brucella* in the milk and the presence of agglutinins in the milk.

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Volume XXI, Number 4, May, 1939

THE INFLUENCE OF CERTAIN HORMONE-LIKE SUBSTANCES ON THE ROOTING OF HARDWOOD BLUEBERRY CUTTINGS

STANLEY JOHNSTON
SECTION OF HORTICULTURE

During recent years considerable interest has been aroused about the possibilities of using plant hormones or synthetic materials of the same nature to stimulate root growth on cuttings of various trees and shrubs, especially those not easily propagated.

For many years the highbush blueberry was classed among those plants difficult to propagate. However, recently methods have been developed that have resulted in high percentages of rooted cuttings although the cuttings develop roots slowly, requiring about three months to become well rooted. It was believed that one of the hormone-like plant growth substances might increase the speed of rooting which would be advantageous as well as possibly increasing the total percentage of rooting.

In the spring of 1937 a propagating frame was filled with a fine grade of German peat moss and planted with 160 cuttings each of the Rubel, Pioneer, Adams, and Cabot blueberry varieties. One-half of the cuttings were treated with a 40-unit solution of Hormodin "A" for 24 hours. The recommendations for the use of this material on blueberry cuttings did not give the suggested treatment for hardwood cuttings so the standard recommendation was used. This experiment did not include greenwood, leafy cuttings as hardwood cuttings have many practical advantages and are much preferred by commercial blueberry nurserymen. The solution apparently was not too strong as no evidence of injury could be observed in the cuttings. A duplicate planting

Table 1. Influence of Hormodin "A" on the length of time required to root blueberry cuttings, 1937.

Cuttings planted April 20. Ten of each variety examined on each date.

	May 20	June 4	June 18	July 1
TREATED:				
Rubel	0	0	0	4 (starting)
Pioneer	0	0	3 (starting)	8
Adams	0	0	4	8
Cabot	0	0	1	10
UNTREATED:				
Rubel	0	0	0	2
Pioneer	0	0	0	1
Adams	0	0	0	1
Cabot	0	0	4 (starting)	8

NOTE: All root systems were small on July 1.

Table 2. Influence of Hormodin "A" on the percentage of rooting of blueberry cuttings, 1937.

(40 cuttings in lot)

	Number Rooted	Per cent Rooted
TREATED:		
Rubel	39	97.5
Pioneer	28	70.0
Adams	39	97.5
Cabot	33	82.5
UNTREATED:		
Rubel	40	100.0
Pioneer	39	97.5
Adams	40	100.0
Cabot	39	97.5

was made in the other half of the frame with untreated cuttings; therefore, the cuttings in each lot were growing under the same conditions of light, moisture, and temperature.

The cuttings were planted April 20, and 10 of each variety in each

Table 3. The influence of Hormodin "A" and Auxilin on the speed of rooting of blueberry cuttings, 1938.

(20 cuttings in each lot)

Variety and Treatment		Dates of Examination and Number of Cuttings Showing Roots		
		June 1	June 21	July 12
Rubel	Auxilin 2	0	2	5
Adams	Auxilin 2	0	1	4
Cabot	Auxilin 2	0	5	5
Pioneer	Auxilin 2	0	3	4
Rubel	Check	0	2	5
Rubel	Auxilin 3	0	3	4
Adams	Auxilin 3	0	3	4
Cabot	Auxilin 3	0	4	5
Pioneer	Auxilin 3	0	4	3
Adams	Check	0	1	4
Rubel	Auxilin 4	0	0	4
Adams	Auxilin 4	0	4	4
Cabot	Auxilin 4	2	5	5
Pioneer	Auxilin 4	0	5	4
Rubel	Hormodin "A" 20	0	1	5
Adams	Hormodin "A" 20	0	3	4
Cabot	Hormodin "A" 20	0	5	5
Pioneer	Hormodin "A" 20	1	4	5
Cabot	Check	1	5	5
Rubel	Hormodin "A" 40	0	3	5
Adams	Hormodin "A" 40	0	1	5
Cabot	Hormodin "A" 40	1	5	5
Pioneer	Hormodin "A" 40	0	3	5
Pioneer	Check	2	3	4
Rubel	Hormodin "A" 80	0	1	4
Adams	Hormodin "A" 80	0	4	5
Cabot	Hormodin "A" 80	1	3	4
Pioneer	Hormodin "A" 80	1	4	4

NOTES:
Five cuttings lifted in each lot on each date.
June 1 —Roots just starting.
June 5 —Root systems all very small.
June 21—Root systems on Cabot larger than others. Rubel root systems smallest.

half of the frame were examined at two-week intervals beginning May 20. The results of these examinations are shown in Table 1. No rooting started until June 18 and on July 1 some root formation had started in all lots although the root systems were all small. A higher percentage of cuttings were beginning to root by July 1 among those treated with Hormodin "A". However, rooting had not been speeded sufficiently to be of any commercial significance.

At the end of the season, the 40 remaining cuttings of each variety in the treated and untreated lots were examined; the results are shown in Table 2. Better results were obtained with all varieties that were untreated, the difference being significant with Pioneer and Cabot. No difference in size of plants could be observed.

Further Investigations

In 1938 the experiment was continued and broadened to include other concentrations of Hormodin "A" and also to include three concentrations of Auxilin. Twenty,- forty,- and eighty-unit solutions of Hormodin "A" were used, and suggested strength of treatment numbers 2, 3, and 4 of Auxilin. The basal ends of all lots of cuttings were soaked in these solutions for 16 hours, thoroughly rinsed, and planted. The cuttings for that part of the experiment concerning the speed of rooting, were all planted in one propagating frame and those used to determine the total percentage of rooting were all planted in another frame, thus making certain that comparative lots were grown under the same conditions.

Table 4. The influence of Hormodin "A" and Auxilin on the total number of hardwood blueberry cuttings rooting, 1938.

(20 cuttings in each lot)

Variety and Treatment		Total Number Cuttings Rooted
Rubel	Auxilin 2	18
Adams	Auxilin 2	12
Cabot	Auxilin 2	19
Pioneer	Auxilin 2	10
Rubel	Check	19
Rubel	Auxilin 3	20
Adams	Auxilin 3	12
Cabot	Auxilin 3	20
Pioneer	Auxilin 3	18
Adams	Check	12
Rubel	Auxilin 4	20
Adams	Auxilin 4	16
Cabot	Auxilin 4	18
Pioneer	Auxilin 4	19
Rubel	Hormodin "A" 20	20
Adams	Hormodin "A" 20	14
Cabot	Hormodin "A" 20	18
Pioneer	Hormodin "A" 20	14
Cabot	Check	15
Rubel	Hormodin "A" 40	19
Adams	Hormodin "A" 40	14
Cabot	Hormodin "A" 40	19
Pioneer	Hormodin "A" 40	18
Pioneer	Check	19
Rubel	Hormodin "A" 80	20
Adams	Hormodin "A" 80	12
Cabot	Hormodin "A" 80	17
Pioneer	Hormodin "A" 80	15

Table 3 gives the results obtained in that part of the experiment devised to determine the influence of various strengths of Hormodin "A" and Auxilin on the speed of rooting. The use of these materials apparently did not cause the cuttings to form roots in less time. If there were any differences in certain instances, they were so insignificant as to be commercially unimportant.

The data regarding the influence of the materials on the total percentage of rooting are shown in Table 4. In 1937 Pioneer and Cabot cuttings treated with Hormodin "A" did not root as well as those untreated. In 1938 similar results occurred with reference to Pioneer, but certain lots of the treated cuttings of Adams and Cabot reacted better than did the untreated. It seemed to make little difference with Rubel whether the cuttings were treated.

Reviewing the two years' work, it is apparent that the use of Hormodin "A" and Auxilin was of little value in producing speedier root formation in blueberry cuttings. The data on total percentage of rooting are slightly more inconclusive, although there is little if any evidence to prove the value of the added expense and trouble of using the materials in blueberry propagation.

While the results of this experiment indicate that those materials, which have been useful in stimulating root formation on cuttings of some other plants, were not useful in that respect with blueberries, it is quite possible that in the future similar, or perhaps entirely different, substances may be found which will prove to be of value with certain blueberry varieties especially difficult to propagate.

THE INFLUENCE OF DIFFERENT LEVELS OF FAT IN THE RATION UPON MILK AND FAT SECRETION

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The relation of the quality and quantity of fat in the ration of dairy cattle to milk and fat production has received the attention of many investigators. Literature on this problem has been reviewed by Allen (1), Maynard and McCay (2), M'Candlish and Struthers (3), Anderson and Williams (4) and Garner and Sanders (5). Allen (1) and Garner and Sanders (5) showed that the addition of various fats resulted in an increased percentage of fat in the milk. Maynard and McCay (2) reported that a certain amount of food fat was necessary for optimum milk secretion. This article gives the results of an experiment designed to study the effect of different fat levels in the ration on the butterfat test and on milk production.

Experimental

Eight milking cows were divided into two groups (A and B) of four animals each and used in a double reversal experiment. The breed, age, calving date, and basal rations are shown in Table 1. It was neces-

Table 1. History of cows and basal rations used.*

No. Cow	Age	Weight**	Breed	Days** Since Last Calving	Basal Ration		
					Alfalfa	Beet Pulp	Molasses
	Years	Pounds			Pounds	Pounds	Pounds
Group A							
171.........	9	1,407	Holstein......	182	22	15	3
246.........	6	1,260	Brown Swiss..	139	22	15	3
7.........	9	1,110	Guernsey.....	85	20	13	3
66.........	8	970	Jersey........	119	20	11	3
Group B							
218.........	3	1,315	Holstein......	138	22	14	3
242.........	9	1,440	Brown Swiss..	79	22	13	3
99.........	4	1,059	Jersey........	47	20	13	3
101.........	3	968	Jersey........	97	20	11	3

*Bonemeal fed to all animals.
**At beginning of experiment.

sary to use Jersey cow 99 in Group B to pair with Guernsey cow 7 in Group A. All the cows were in a good condition of flesh at the beginning of the experiment.

It was planned to keep the alfalfa, molasses and solvent-extracted soybean oil meal constant and make sugar beet pulp the variable.

The digestible protein, total digestible nutrients and ether extract of the feeds used in this investigation are shown in Table 2.

Four-day composite samples of milk were tested for butterfat. All the cows were fed the same ration during a four-day preliminary period. Group A received the basal ration low in fat supplemented with soybean oil during the period I. Group B received the basal ration low in fat during the first period. The groups were reversed at the end of each 24-day period.

During the periods when soybean oil was fed, it replaced an isodynamic amount of beet pulp. Enough soybean oil was added to the ration of each cow so that the total ether extract of the ration was equal to

Table 2. The digestible protein, total digestible nutrients, ether extract content of feeds used.*

	Digestible** Crude Protein	Total Digestible** Nutrients	Ether Extract
Alfalfa hay..	10.72	50.7	1.77
Beet pulp..	4.50	68.7	0.40
Molasses (beet)..	7.38	59.6	—
Soybean oil meal (solvent)..	39.1	78.0	0.70
Corn..	9.70	81.5	3.30
Barley..	12.39	74.50	1.00

*Chemical analyses of feeds by Section of Experiment Station chemistry.
**Used coefficients of digestibility in Feeds and Feeding, 20th ed., by Morrison.

Table 3. Effect of supplementing the basal ration fed to the cows in Group A with soybean oil.

4-day Periods	Average Daily Milk	Average Daily Butterfat	Fat	Average Daily 4% F.C.M.
	Pounds	Pounds	Per Cent	Pounds
Jan. 10-13	32.5	1.42	4.3	34.0
Period I—High Fat Ration				
Jan. 14-17	33.65	1.45	4.3	34.99
Jan. 18-21	30.20	1.29	4.3	33.46
Jan. 22-25	31.15	1.30	4.2	31.96
Jan. 26-29	31.01	1.27	4.1	31.38
Jan. 30-Feb. 2	31.19	1.29	4.1	31.83
Feb. 3-6	31.29	1.34	4.3	32.58
Period II—Low Fat Ration				
Feb. 7-10	30.78	1.09	3.5	28.62
Feb. 11-14	29.35	1.09	3.7	28.09
Feb. 15-18	27.20	1.11	4.1	27.49
Feb. 19-22	25.94	1.07	4.1	26.46
Feb. 23-26	24.67	1.04	4.2	25.51
Feb. 27-Mar. 1	24.53	1.00	4.1	25.22
Period III—High Fat Ration				
Mar. 2- 5	25.52	1.20	4.7	28.21
Mar. 6- 9	26.91	1.15	4.3	28.09
Mar. 10-13	28.36	1.20	4.2	29.38
Mar. 14-17	27.38	1.15	4.2	28.20
Mar. 18-21	27.76	1.08	3.9	27.30
Mar. 22-25	27.46	1.09	4.0	27.41

Table 4. Effect of supplementing the basal ration fed to the cows in Group B with soybean oil.

4-day Periods	Average Daily Milk	Average Daily Butterfat	Fat	Average Daily 4% F.C.M.
	Pounds	Pounds	Per Cent	Pounds
Jan. 10-13	33.24	1.41	4.2	34.48
Period I—Low Fat Ration				
Jan. 14-17	32.10	1.35	4.2	33.09
Jan. 18-21	29.73	1.30	4.4	31.42
Jan. 22-25	28.86	1.28	4.4	30.71
Jan. 26-29	27.33	1.24	4.5	29.49
Jan. 30-Feb. 2	27.42	1.30	4.7	30.47
Feb. 2- 6	26.98	1.25	4.6	29.61
Period II—High Fat Ration				
Feb. 7-10	29.22	1.44	4.9	32.84
Feb. 11-14	30.97	1.47	4.7	34.44
Feb. 15-18	32.53	1.51	4.6	35.66
Feb. 19-22	33.68	1.50	4.4	35.94
Feb. 23-26	33.37	1.36	4.1	33.78
Feb. 27-Mar. 1	33.29	1.33	4.0	33.27
Period III—Low Fat Ration				
Mar. 2- 5	33.54	1.14	3.4	30.48
Mar. 6- 9	29.91	1.13	3.8	28.99
Mar. 10-13	28.47	1.10	3.8	27.85
Mar. 14-17	26.05	1.07	4.1	26.47
Mar. 18-21	25.35	1.05	4.1	25.85
Mar. 22-25	23.96	1.05	4.4	25.37

daily butterfat production. The soybean oil was added to the hay and beet pulp. The results are shown in Tables 3 and 4 and in Fig. 1.

At the end of the third period three of the cows in Group A (cows 171, 245, and 66) and three of the cows in Group B (cows 218, 242, and 101) were continued on experiment. Cow 7 of Group A and cow

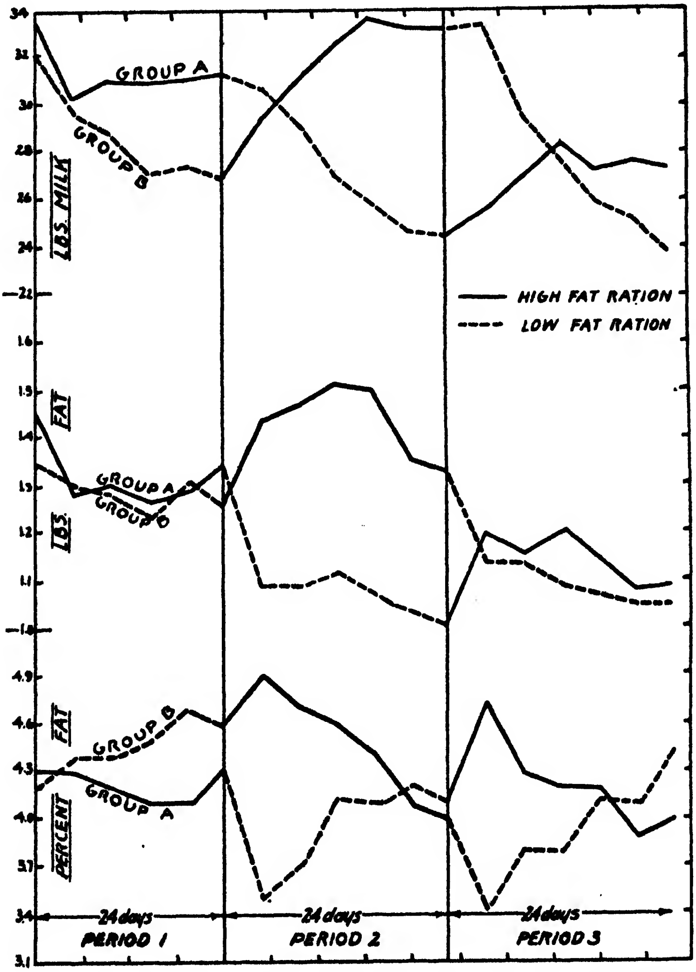

Fig. 1. The effect of adding soybean oil to a ration low in fat on milk production and the percentage of fat in milk.

99 of Group B were not used owing to the development of acute mastitis. The beet pulp and soybean oil were replaced with an isodynamic amount of corn in Group A; while in Group B, which received the low-fat ration during period III, the beet pulp was replaced by an isodynamic amount of barley. The results are shown in Table 5 and Fig. 2. Body weights were not significantly affected.

Table 5. Effect of replacing beet pulp with corn in a low-fat ration and beet pulp and soybean oil with barley in a high-fat ration.

Periods	Group B				Group A			
	Average Daily Milk	Fat	Average Daily Butterfat	Average Daily 4% F.C.M.	Average Daily Milk	Fat	Average Daily Butterfat	Average Daily 4% F.C.M.
	Pounds	Per Cent	Pounds	Pounds	Pounds	Per Cent	Pounds	Pounds
	Basal low in fat				Basal plus soybean oil			
1	34.42	3.14	1.083	30.02	27.29	4.38	1.197	28.87
2	31.43	3.41	1.073	28.67	29.11	3.95	1.153	28.94
3	30.47	3.60	1.097	28.64	30.80	3.93	1.213	30.52
4	28.01	3.77	1.057	27.05	29.64	3.90	1.157	29.21
5	27.62	3.80	1.050	26.80	29.96	3.58	1.073	28.15
6	25.15	4.01	1.010	25.18	30.05	3.70	1.110	29.69
	Basal plus corn				Basal plus barley			
7	27.72	3.99	1.107	24.83	30.51	3.20	.990	30.21
8	30.58	3.94	1.207	30.30	28.60	3.30	.943	25.59
9	30.81	3.84	1.183	30.08	27.29	3.40	.937	24.99
10	29.50	3.86	1.140	28.90	25.87	3.40	.903	23.86
11	30.34	3.89	1.183	29.89	26.06	3.70	.963	24.95

Discussion

Effect on the Percentage of Fat—The results show that the addition of soybean oil to the basal ration low in ether extract (alfalfa, beet pulp, molasses, solvent-extracted soybean oil meal and bone meal) resulted in a pronounced temporary increase in the fat percentage in milk. The animals in Group A during period II tested 4.1 per cent during the four-day period previous to the addition of soybean oil. The fat percentage increased to 4.7 during the four-day period immediately following the soybean oil addition. Similar results but not so pronounced were observed with the animals in Group B. Milk of those animals averaged 4.6 per cent fat during the final four-day period on the basal ration low in fat and increased to 4.9 per cent fat for the four days following the change to a high-fat ration. The increase in fat percentage following the change to soybean oil was of short duration. The cows, however, showed considerable variation in this respect. This initial increase in butterfat percentage was not observed when corn replaced beet pulp for the three animals in Group A. When barley replaced soybean oil and beet pulp in the ration of the animals in Group B, there was a drop in butterfat percentage.

The results of this investigation with soybean oil agree with those of Allen (1) and Garner and Sanders (5) who reported an increase in the fat percentage in milk over a period of five or six days when various oils were added to a ration low in ether extract. In the work here reported the increase in butterfat test lasted from four to about 12 days when the tests returned to normal and then decreased slightly below normal. The results with corn, however, are not in agreement with those of Allen. It appears that the temporary increase in butterfat percentage due to the addition of fat depends on the basal ration used. This may account for the results of M'Candlish and Struthers (3) and others who failed to observe an increase in butterfat percentage after the addition of fat.

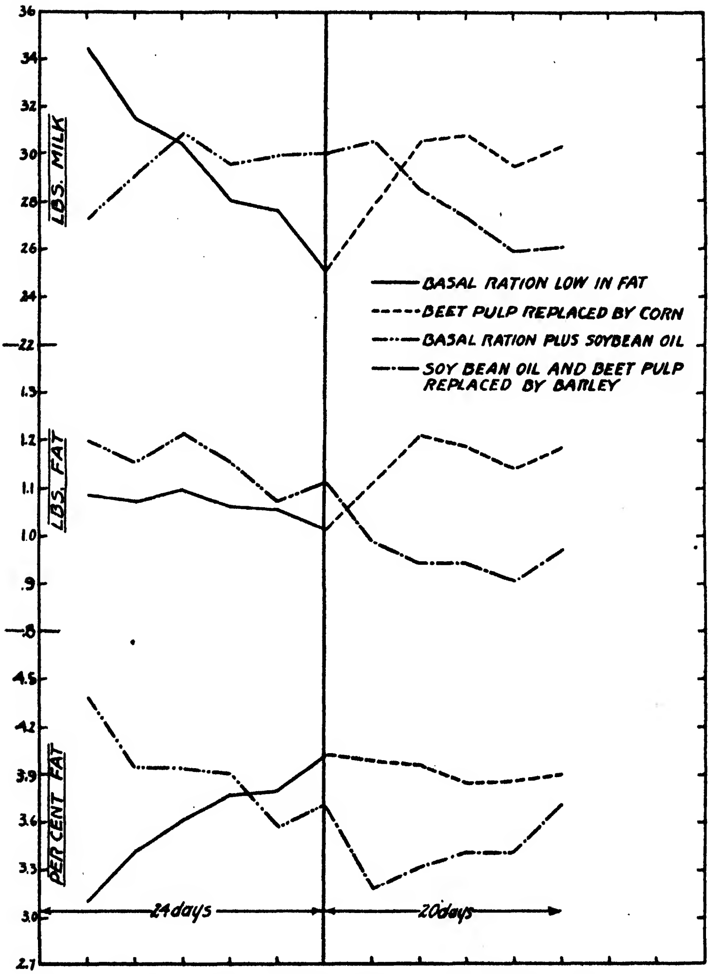

Fig. 2. The effect of replacing beet pulp with corn in a low-fat ration and the effect of replacing beet pulp and soybean oil with barley in a high-fat ration.

The effect of changing from the basal ration plus soybean oil to the basal ration low in fat resulted in a temporary drop in fat percentage, which was followed by a marked increase. Maynard and associates observed a similar increase in fat percentage on the low-fat ration which they used. Similar results were obtained when barley replaced soybean oil and beet pulp in the ration.

Effect on Milk Production

There was a decrease in milk production in both groups of cows when fed the ration low in fat. There was likewise an increase in milk when the animals were changed from the basal ration low in fat to soybean

oil. The increase was more marked in case of the animals in Group B. Similar results were obtained when corn replaced beet pulp in the basal ration.

When barley replaced soybean oil and beet pulp in the ration of the animals in Group B, there was a drop in milk production.

These results are in agreement with those of Maynard and associates who showed that a certain amount of food fat is essential for optimum milk production. In a previous work (6) the addition of fats to rations containing corn or corn silage failed to bring about an increase in either milk or the percentage of butterfat.

Summary

1. The addition of soybean oil in place of an isodynamic amount of beet pulp to the basal ration resulted in a temporary increase in butterfat percentage. This increase was of short duration and the fat percentage soon returned to normal.
2. The addition of soybean oil to the basal ration low in fat resulted in an increase in milk production.
3. When beet pulp was replaced by corn in the basal ration, there was an increase in milk production, but the fat percentage in the milk remained unchanged.
4. The feeding of a ration low in fat resulted in an increase in the percentage fat in milk.
5. The basal ration appears to be the important factor in determining the effect of the addition of fat on milk and fat secretion.

Literature Cited

1. Allen, N. N. The Fat Percentage of Milk as Affected by Feeding Fats to Dairy Cows. Jour. Dairy Sci. **17**: 379, 1934.
2. Maynard, L. A. and C. M. McCay. The Influence of Different Levels of Fat Intake Upon Milk Secretion. Cornell U. Agr. Exp. Sta. Bul. 543, 1932.
3. M'Candlish, C. and J. P. Struthers. Feeding Butterfat to Dairy Cows. Jour. Dairy Res. **6**: 303, 1935.
4. Anderson, W. E. and H. H. Williams. The Role of Fat in the Diet. Physiol. Rev. **17**: 335, 1937.
5. Garner, F. H. and H. G. Sanders. A Study of the Effect of Feeding Oils to Dairy Cows and the Value of the Fat in Square Lay-out in Animal Experimentation. Jour. Agr. Sci. **28**: 35, 1938.
6. Unpublished Data—Dairy Section of the Michigan Agricultural Experiment Station.

PERMANENCE OF SIZE DIFFERENCES IN ORCHARD TREES

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The assumption has prevailed that most variations in size of bearing trees within one variety in an orchard can be attributed to local soil conditions such as depth and type of soil in the several horizons, soil drainage, soil fertility, or soil moisture supply, to the seedling stocks on which the varieties were worked, or to injuries of various kinds to the roots or trunks of the trees.

During the process of tabulating results of a long-time pruning experiment it became evident that certain trees which were smaller than their neighbors during the initial years in the orchard were much smaller than other trees at the end of a 15-year period. Likewise, certain trees that were larger than the average after planting in the orchard continued to remain larger than the average trees of the same variety. In view of the facts that the small individuals, as well as the large trees, seemed to be randomized rather than grouped throughout the orchard and that several investigators have reported size differences in fruit plants to be relatively permanent, it seemed advisable to subject the available data to a detailed statistical examination.

Bradford and Joley (1) recently found that there is a tendency for relatively small and large apple nursery seedlings and budded nursery trees to remain small or large, respectively, throughout the nursery growing period, and Tukey and Brase (4) state that the largest one-year whips of cherry and apple became the largest two-year trees in the nursery. Partridge and Veatch (2), working with grape vines of the Concord variety in commercial vineyards, report that vines which were weaker at the beginning of an experiment tended to remain relatively weak and that the stronger vines retained their lead throughout the term of the experiment whether they had been fertilized. Sax and Gowen (3) divided 208 apple trees into 13 classes based on tree trunk girths after they had been growing in the orchard two years and six years later found that the trees which were small at two years of age were relatively small six years later and that the largest trees in the young orchard maintained their superiority year after year.

Orchard Plan and Treatments

The orchard in which the trees under consideration are growing consists of five varieties of four rows each; originally there were nine trees in each row. This block of 180 trees was devoted to a pruning experiment designed to afford comparisons between different amounts of pruning. The trees of the first row of each of the five varieties were pruned severely each year from the time the trees were set in

1919 until they were 15 years old. All branches that did not appear to be essential to the development of a good tree (as generally interpreted at that time) were removed and some heading back was practiced, especially during the first five or six years of the experiment.

Except for the reduction of the number of lateral branches to five or six at time of planting, the trees in the second row of each variety were not pruned until the Duchess, Grimes and Stayman trees were 12 years old and the Baldwin and Northern Spy trees were 15 years of age (the end of the experiment). At the end of the twelfth, thirteenth and fourteenth seasons in the orchard, the Duchess, Grimes, and Stayman trees of these rows were given a corrective treatment designed to eliminate gradually the close crowding of scaffold branches and to remove branches which were too low for practical management of the orchard. Only two or three large limbs were removed each year.

The trees of the third row of each variety were subjected to a disbudding treatment two or three times during each of the first five seasons in the orchard, designed to reduce winter pruning by directing growth into buds at what appeared to be desirable locations. The spring and early summer disbudding were accompanied by a very light winter pruning. These trees were not pruned from the sixth to the fifteenth years, inclusive.

The fourth row of trees of each variety was given a light annual dormant season pruning. In severity, it was about midway between no pruning and the most severe treatment accorded the first row of each variety.

The trees were planted 20 feet apart in either direction and remained at that distance until the orchard had completed 15 years of growth when half of the trees were removed. Trunks of the latter provided the data for Table 3.

At the end of 15 years the missing trees from the original 180 consisted of one Grimes, two Stayman and three Northern Spy, two of the missing Northern Spy trees occurring in the fourth row.

The soil within the area devoted to any one variety is reasonably uniform. All of the orchard under consideration received similar cultural and fertilizer treatments. Some of the Northern Spy and some of the Stayman trees grew in locations that favored greater accumulation of soil moisture during rainfall than did the other locations for trees of these varieties.

Methods for Determination of Relative Size of Trees

The three methods employed for the determination of relative sizes of trees in the orchard are described in the following paragraphs.

Trunk circumference measurements for all trees in the orchard were made at the end of each growing season except the first, seventh, and twelfth years. Cross-sectional areas of the tree trunks were calculated from the circumference measurements for presentation in this article.

From the time the trees in the orchard under consideration were two years old until the end of the pruning experiment the spread of the branches of the trees was measured in two directions, i.e., the diameters of the tree tops were determined for two directions, and the average of the two measurements is assumed to give a fair measure-

ment of the average spread of the trees. The distance from the point of origin of the lowest main branch on the tree trunk to the tip of the highest twig on the tree was measured annually for each tree. Tree top volumes were calculated by the following equation: $V=K{\cdot}H{\cdot}\pi{\cdot}R^2$, in which V is the volume of the tree top in terms of cubic feet; H is the height from the point of origin of the lowest branch to the tip of the highest branch; R is the horizontal radius of a tree; and K is a factor indicative of the extent to which a tree top occupies or fills a solid cylinder. The value for K was calculated for each variety from measurements of many photographs, and it varied from 0.64 in the case of Stayman trees to 0.67 for Grimes and Baldwin trees.*

At the time the filler trees were removed from the orchard, sections of tree trunks about ten inches from the ground line were saved and the widths of the annual rings from time of planting to the completion of the fifteenth growing season in the orchard were measured on two radii and averaged for presentation in Table 3.

Selection of Trees for Size Classification

The nine trees in each row were ranked for size on the basis of cross-sectional areas of tree trunks at the end of the second season in the orchard (the earliest record of this kind available) and the trees of each row were also ranked according to tree size on the basis of tree top volumes at the end of the second season in the orchard, or in cases of ties, the ranking was determined at the end of the third season. Classification on the basis of width of annual rings was omitted from consideration because this involved only the trees that were removed in thinning the orchard. In general, the trees that were smallest or largest as measured by one method were also smallest or largest as measured by the other. In the several cases where the two criteria for size of trees failed to place the same individuals in the same size classes, the writer weighted the rankings for each method of measurement to arrive at a classification.

The nine trees of each row were divided into three classes: the smallest three trees at the time they were two years old constituted the trees designated as "small" in the tables, the three largest trees made a second class designated as "large," and the remaining trees of the row constituted a class intermediate in size and are not considered in this report.

Comparisons of Rates of Growth on Basis of Cross-sectional Areas of Tree Trunks

The average cross-sectional areas of the trunks for the three trees that were smallest and the three trees that were largest in each row of each variety and the averages for 12 trees in each size group for each variety at the completion of 2, 5, 8, 11, and 15 years in the orchard are presented in Table 1. In every case the three trees that were smallest at the end of the second year in the orchard remained smaller than

*The average measurements for eight photographs of trees of the Duchess variety of the same age were as follows: vertical area of tree as determined by planimeter = 10.13 sq. ins.; tree width or spread = 4.03 ins.; height from point of origin of lowest branch to top of tree = 3.83 ins. K = (10.13 ÷ 4.03) ÷ 3.83 = 0.66.

Table 1. Average cross-sectional areas of tree trunks in square inches of three smallest and three largest trees in each row of nine original trees. Classification based on cross-sectional areas and tree top volumes at end of second season in orchard.

Orchard Age of Trees in Years		2		5		8		11		15	
		Size Classification of Trees									
Variety	Row No.	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large
Duchess	1	0.5	0.7	2.3	4.0	9	12	15	22	26	38
	2	0.7	1.0	3.6	5.4	12	17	22	29	36	48
	3	0.5	0.8	3.2	4.3	11	13	20	25	34	40
	4	0.4	0.8	3.1	4.9	12	16	23	29	37	45
	Average	0.5	0.8	3.1	4.6	11	15*	20	26	33	43
Grimes	1	0.7	0.9	5.0	5.6	16	17	28	31	45	47
	2	0.7	0.9	4.6	5.9	15	17	27	30	43	46
	3	0.7	1.2	4.6	6.2	15	16	26	29	41	45
	4	0.6	0.9	5.0	6.7	16	18	28	32	42	47
	Average	0.7	1.0	4.8	6.1	15	17	27	31*	43	46
Baldwin	1	0.8	0.9	3.8	6.7	13	20	26	34	39	53
	2	0.8	0.9	4.5	7.6	15	23	31	42	44	60
	3	0.6	1.0	4.4	5.9	17	23	34	43	51	60
	4	0.7	0.9	4.3	6.0	16	22	29	41	41	57
	Average	0.7	0.9	4.2*	6.6	15	22	30	40	44	58*
Stayman	1	0.5	1.0	3.9	6.1	14	19	24	32	38	44
	2	0.8	1.1	5.1	6.6	18	19	33	34	46	51
	3	0.6	1.0	5.1	6.5	17	20	32	35	49	51
	4	0.8	1.1	5.0	6.9	16	20	30	36	47	55
	Average	0.7	1.1	4.8	6.5	16	19*	30	34	45	50
Northern Spy	1	0.5	0.9	4.2	6.4	11	18	19	32	30	51
	2	0.8	0.9	6.0	7.5	18	21	28	37	46	53
	3	0.5	1.0	5.1	6.6	15	19	29	35	46	55
	4	0.6	0.8	4.8	6.0	16	17	32	29	49	46
	Average	0.6	0.9	5.0	6.6	15	19	27	33	43	51
AVERAGE		0.6	0.9	4.4	6.1	14	18	27	33	42	50

*There may appear to be some inconsistencies in rounding averages in this and other tables. For instance, the small Baldwin trees at age 5 would appear to give an average cross-sectional area of 4.25, which should be rounded to 4.3 rather than 4.2. The figures actually averaged, however, were 3.80, 4.50, 4.42 and 4.26, giving an average of 4.24, which is rounded to 4.2.

the trees that were largest at the end of two years. In other words, trees that were small shortly after the orchard was planted were, on the average, destined to remain smaller than neighboring trees; trees that were larger than the average in the young orchard were still the largest trees when the orchard was 15 years old.

The averages for each variety are presented even though there may be some question as to whether it is technically correct to attempt to average trees that have been subjected to four different pruning treatments that have resulted in considerable differences in growth response. All of the differences between the average size of trees for each of the five varieties and in each of the years designated are statistically significant despite the high probable errors due to differences in growth response caused by pruning treatments, except the following: Grimes at the end of the fifteenth year, Stayman at the end of the eleventh and fifteenth years, and Northern Spy at the end of the fifteenth year.

The general averages for the five varieties afford an easier comparison of tree sizes of the two classes at the various ages. All of these differences between trees of the same age are highly significant. At the completion of 15 seasons in the orchard the third of the trees that were classified as large shortly after the orchard was established were nearly 20 per cent larger, according to this method of measurement, than the third constituting the small class.*

Figure 1 presents essentially the same information as the last line of Table 1 except that the available data for the intervening years have been incorporated. This graph shows that not only do the trees that are small when young continue to remain smaller than their neighbors but that the relative differences in tree sizes (in terms of time required to grow the difference in size of trees) tend to increase. When these varieties were ten years old, the trees that were largest at two years of age were approximately one growth year larger than the trees that were originally classified as small. By the time that this orchard was 15 years old, the trees that were largest at two years were nearly one and one-half growing seasons ahead of the poorer group as expressed by cross-sectional areas of tree trunks.

The orchard completed 20 seasons growth in 1938. Five years earlier one-half of the trees were removed in the process of orchard thinning and during the five-year period two Baldwin trees of the "large" classification were removed because of winter injury. At the end of the 1938 growing season, 30 of the 72 trees that were classified as small when two years old and likewise 30 of the 72 trees that were classified as large remained. In most cases one or two of the original three trees of each classification remained in a row, though in one row of Baldwin none of the small trees remained and in another row of Baldwin and in one row of Duchess none of the large trees remained. In only one row of Duchess were the three trees that were classified as large available for measurement in the fall of 1938.

*Inasmuch as the general averages show that the large trees were 50 per cent larger than those of the small class at two years of age, and the percentage differences tend to decrease with increase in age of trees, it might be contended that size differences tend to disappear with increase in the age were it not for the fact that such reasoning is fallacious. A 20 per cent difference in size of trees at 20 years of age represents a greater difference in growing time and capacity to function than a 50 per cent difference at two years of age.

Obviously, comparisons of tree size as indicated by cross-sectional areas of tree trunks within individual rows would have little significance under such conditions. Differences in pruning treatments of the four rows of each variety and the lack of uniformity in numbers of trees of each row that can be averaged make the differences that exist between averages within a variety of less significance than those that have been presented in preceding paragraphs. Nevertheless, these averages for varieties are presented for what they may be worth.

The average cross-sectional areas of tree trunks in square inches at the time the orchard was 20 years old for trees classified as small and for those classified as large, respectively, are as follows: Duchess, 53 and 60; Grimes, 67 and 72; Baldwin, 69 and 106; Stayman, 65 and 71; and Northern Spy, 69 and 83. When all varieties are averaged, the trees that were classified as small at two years from planting time have 66 square inches of cross-sectional trunk area while those that were classified as large have an average area of 76 square inches. The differences in average size of trees of each variety and for the group as a whole, as expressed in percentages, remain essentially the same at 20 years of age as at 15 years from planting. Thus, the limited data available at the time the orchard was 20 years old indicates that differences in size of trees at two years of age remained permanent.

Comparisons of Rates of Growth on Basis of Tree Top Volumes

Table 2 shows the average annual rate of increase in tree top volumes for the trees classified as small and as large for each variety. Obviously, such a table would be too voluminous if attempts were made to show the size of trees of each classification for each row of each variety for each of 14 years. Each figure presented in all but the last two columns is an average for 12 trees. The 12 trees, in the case of the small classification, consist of the three smallest trees of Row 1, the three smallest of Row 2, the three smallest of Row 3 and the three smallest of Row 4, rather than the 12 smallest of a possible 36 trees irrespective of pruning treatments. The trees composing these groups are identical with those used for Table 1.

In all but the last two columns, the figures have been rounded to the nearest unit of ten when the volumes exceeded 150 cubic feet and to the nearest unit of 100 when the volumes exceeded 2,000 cubic feet.

A few instances will be noted in which the trees were apparently smaller one season than one year earlier. These trees were standing 20 feet apart until the termination of the experiment, that was designed to compare differences in severity of pruning. Therefore, even a thinning-out type of pruning might reduce the spread or height of a tree materially and, in addition, occasional heading back was practiced to facilitate orchard operations.

The tendency for trees that were small, when the orchard was young, to remain relatively smaller than the trees that were initially classified as large is much the same as that found in Table 1. In every instance, the average of 12 trees classified as small continued to average smaller in tree top volume than did the 12 trees classified as large. In the cases of Grimes and Stayman, the average differences in size are not

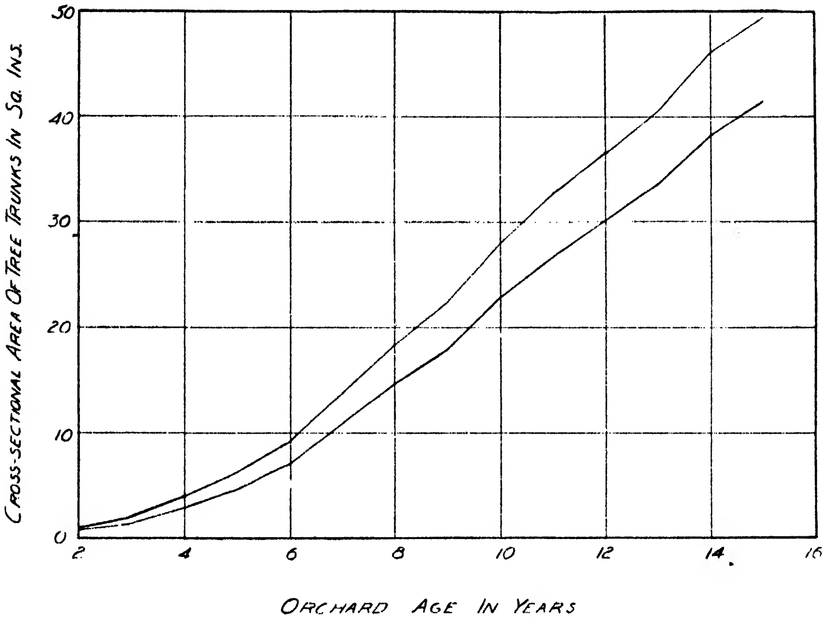

Fig. 1. The lower line shows the rate of growth of the trees that were classified as smallest of their respective rows at two years of age and the upper line shows the rate of growth for the trees classified as large. Each line represents an average for 60 trees of five varieties.

great but they are, nevertheless, rather consistent. Much the same condition is evident in Table 1.

The figures presented in the last two columns of Table 2 are averages of the figures appearing in the preceding columns. All differences for trees of the same ages in those columns are statistically significant even though each size classification is composed of trees subjected to different pruning treatments that resulted in different growth responses.

Comparisons of Rates of Growth on Basis of Annual Ring Increments

Inasmuch as there were nine original trees in each row and alternate trees were removed at the end of 15 years, not to exceed four tree trunks would be available in half the rows and not more than five tree trunks in the other rows for sectioning. It was therefore decided to select the one tree of four or five in each row that was smallest at time of planting for the "small" class and the one that was largest for the "large" class. These trees were chosen without reference to the classification for preceding tables. Four trees, one from each row of a variety, were averaged to give the figures for each size classification presented in Table 3.

This method of comparing the rates of growth of the trees shows that size differences that were apparent at planting time have persisted throughout the 15-year period for which data are available. There is some indication that the differences in rates of growth between the

Table 2. Tree top volumes in cubic feet. Averages of three smallest and three largest of nine trees in each of four rows per variety. Size classification made at end of second growing season in orchards.

Variety.....	Duchess		Grimes		Baldwin		Stayman		Northern Spy		Average	
Orchard Age of Trees in Years	Size Classification of Trees											
	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large
2..........	5	8	10	21	8	15	24	37	6	10	10	18
3..........	13	28	24	42	21	45	47	73	15	23	24	42
4..........	33	73	88	130	58	115	160	210	48	75	79	122
5..........	76	140	130	190	140	210	290	370	86	140	143	212
6..........	170	260	310	400	290	440	570	720	180	250	303	414
7..........	270	410	490	640	410	630	890	1,020	280	390	467	634
8..........	440	660	780	1,010	680	1,000	1,320	1,520	450	620	736	960
9..........	600	810	1,020	1,240	940	1,290	1,650	1,840	730	900	985	1,260
10..........	810	1,120	1,360	1,550	1,260	1,730	2,000	2,200	980	1,250	1,285	1,580
11..........	1,320	1,710	1,890	2,100	1,820	2,500	2,600	2,800	1,460	1,770	1,820	2,190
12..........	1,690	2,200	2,200	2,600	2,600	3,400	3,600	3,700	1,860	2,200	2,390	2,830
13..........	2,000	2,500	2,500	2,800	2,400	3,300	3,700	3,900	2,300	2,700	2,580	3,050
14..........	2,200	2,900	3,000	3,500	3,100	4,200	4,100	4,400	3,000	3,700	3,080	3,720
15..........	2,900	3,700	3,700	4,000	3,600	5,000	4,800	5,300	3,900	4,600	3,790	4,520

small and large Duchess, Stayman and Northern Spy trees have increased with age of trees, that the differences in the case of Grimes have merely persisted, and that the differences between the two classes of trees widened for a time in the case of Baldwin, followed by a narrowing of differences. The numbers of trees involved, however, are not great enough to warrant the placing of a great amount of emphasis on these apparent trends. The data are valuable to the extent that they substantiate the two preceding tables.

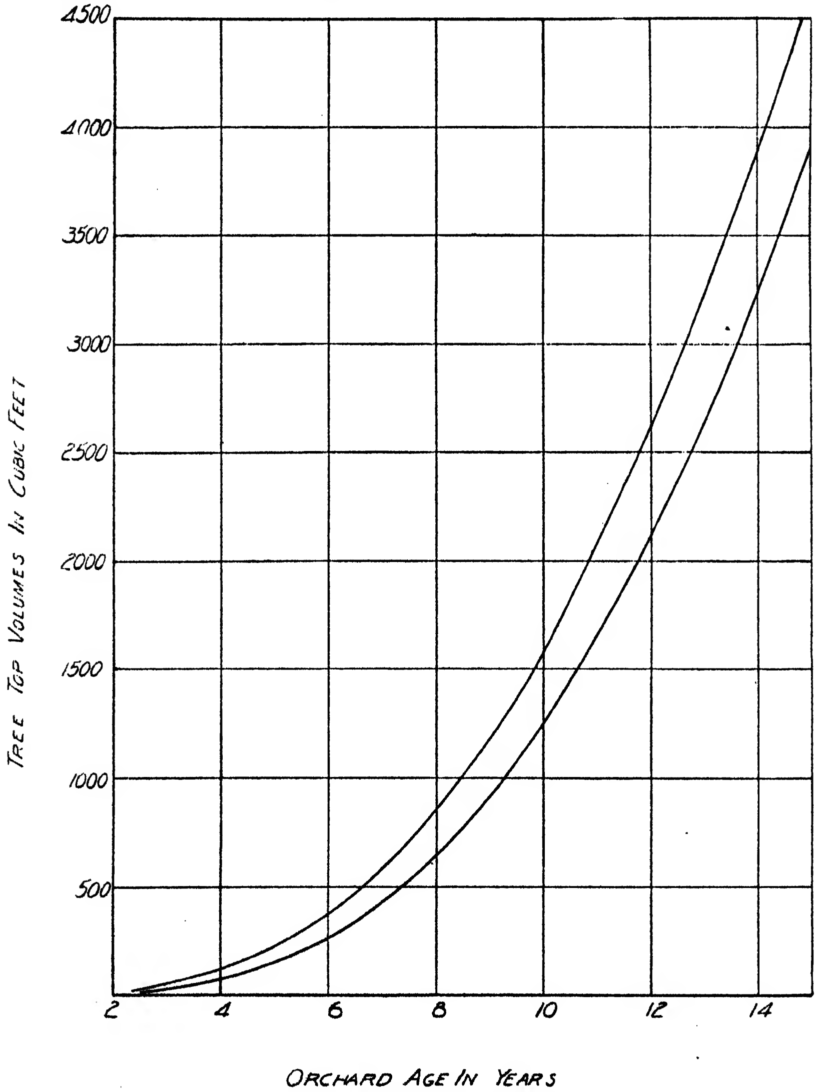

Fig. 2. Rate of growth curves for small and large trees, calculated from data presented in the last two columns of Table 2. The trees that were small at two years of age were approximately one growth year smaller than the trees of the large group when the orchard was 12 to 15 years old.

Table 3. Average radial increases in terms of accumulated totals for the smallest and the largest filler tree of each of four rows for each variety. Classification based on thickness of woody portion of stem at time of planting. (Millimeters)

Variety	Duchess		Grimes		Baldwin		Stayman		Northern Spy		Average	
Orchard Age of Trees in Years	Size Classification of Trees											
	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large
1	2	3	2	4	2	3	3	3	2	3	2	3
2	4	7	6	8	5	8	6	8	6	8	5	8
3	7	13	12	14	8	13	11	14	12	15	10	14
4	12	19	19	21	13	21	18	22	20	23	16	21
5	17	25	26	28	21	28	25	29	26	30	23	27
6	23	32	33	35	28	36	32	37	32	36	30	35
7	28	39	41	44	38	45	41	46	40	45	38	44
8	35	46	47	50	47	53	49	54	48	53	45	50
9	39	50	54	57	54	60	56	62	54	59	51	57
10	45	58	61	64	62	68	64	70	62	67	59	65
11	50	64	66	70	68	74	70	76	68	72	64	71
12	54	69	71	75	72	78	74	82	72	77	69	76
13	57	72	75	78	77	83	79	87	77	83	73	80
14	64	78	82	84	82	87	84	92	82	88	79	85
15	66	81	85	87	85	89	87	95	85	92	82	88

Initial Size Differences May Not Remain Permanent

The data presented thus far have been averages for 3 to 12 trees per variety or, in the case of general averages, for 20 to 60 trees. As might be expected, there were a few individual trees classified as small when they were young that grew as rapidly or even faster than trees in the same row classified as large and *vice versa*.

One of the Stayman trees of Row 2 (unpruned) was classified as one of the three largest trees of the row at two years of age. After 15 years in the orchard it showed a cross-sectional area for the trunk of 44 sq. ins. compared with 46 sq. ins. for the average of the three trees originally classified as small and a tree top volume of 4,550 cubic feet compared with an average of 4,800 for the three small trees. Even though this Stayman tree had what appeared to be potential possibilities of becoming one of the three largest trees in the row, it actually became the third smallest tree of the row as measured in terms of the tree trunk and next to the smallest tree as measured in terms of tree top volume.

One of the Northern Spy trees of Row 4 that was the largest one of the row in terms of both trunk measurement and tree top volume actually became the smallest tree in the row by both criteria of size when the orchard reached an age of 15 years. This individual maintained its lead over all other trees in the row for five years and then began to decline in rate of growth. The behavior of this one tree was such as to make the average difference in size for this variety hardly significant, statistically, at 15 years of age.

One of the Grimes trees of Row 4 was the smallest tree of this row at the end of the second season in volume of top and was one of the two smallest as determined by trunk measurement. At the time the orchard was 15 years old, the tree had a trunk cross-sectional area of 47 sq. ins., which is equivalent to the average for the three trees of the row classified as large and the volume for the tree top was calculated at 4,600 cubic feet, which is the largest tree top volume for that row and the fourth largest for all Grimes trees.

The foregoing instances have been cited to explain that some individuals that were vigorous growing in the nursery or immediately after planting may become weak or small trees in later years and those that are apparently weak in the young orchard may become strong growing trees. Such deviations from the normal trend of weak trees to remain relatively weak ones and for large trees at least to retain their growth leads may be explained by very local soil environments, winter and other types of injuries, root stocks and other factors mentioned in the first paragraph of this paper.

Discussion

The data presented in tabular and graphical form show that, on the average, trees that are smaller than the average when the orchard is two years old are likely to remain smaller than the average and that large trees in the young orchard may be expected to develop bearing trees that are larger than the average and therefore have greater bearing capacity.

Other data (Table 3) indicate that trees showing large caliper at the time of planting the orchard are likely to become the larger trees

in the bearing orchard. In other words, size differences, within certain limits, at planting time are likely to remain permanent in the orchard.

No information is available to show the size (nursery grade) of the trees that were delivered from the nursery for the planting of this orchard. It may be assumed, however, that well grown nursery stock, reasonably uniform and perhaps above average size was requested and delivered for a planting that was destined for experimental use. In such a case, the range in sizes, as indicated by height of tree or caliper of tree trunk, would not be great. The data presented in this paper then must not be interpreted as a comparison between rates of growth of trees from two different nursery grades but rather between trees within one size grade where there was probably not to exceed one foot difference in height between the smallest and largest trees of a variety. One might estimate, on the bases of data presented by Bradford and Joley (1) and in this article, that bearing orchard trees grown from two-year nursery trees of the 5- to 6-foot grade would be very much larger than those grown from 4- to 5-foot trees and that one would never be justified in planting the smaller two-year stocks. One-year nursery apple trees are offered by some nurserymen in several size grades such as 2 to 3 feet, 3 to 4 feet, 4 to 5 feet and sometimes 5 to 6 feet. If differences in rates of growth in the orchard are substantial between trees within the same size grade, there must be very great differences in growth response in the orchard following the setting of trees from 2- to 3-foot nursery stock and 5- to 6-foot stock.

The data presented indicate that the larger the size of the nursery stock planted, the larger will be the trees in the bearing orchard. There were probably no very large nursery trees planted in this block. It may be assumed that the larger of the trees planted in this orchard would be termed medium large or above medium in size. Whether there is an upper size limit for nursery grown apple trees, above which size the trees fail to maintain the faster growth rates, is not known.

In general, one must conclude that when the grower is offered a choice of sizes of nursery trees for planting for commercial purposes the larger trees should be procured, even at some price premium, for such trees may be expected to be one or more years larger in size and bearing capacity at 10 to 15 years of age and a few more apples in any one of those years will more than compensate for the original price differences for nursery stock.

Twenty-five dollars per acre per year is not considered a high rate of increase in value of well located young apple orchards. If an orchard at 15 years of age is one or two growth years smaller than another planted at the same time, it represents an inventory value of \$25 to \$50 or more less per acre. These values should be borne in mind when selecting or ordering nursery stock.

Summary

The nine trees in each of 20 rows involving five varieties of apples were divided into three size groups on the bases of cross-sectional areas of tree trunks and tree top volumes after the completion of two growing seasons in the orchard and the relative rates of growth of

the trees constituting the smallest trees and the class of largest trees were determined until the orchard was 15 years old.

On the average, the small trees remained substantially smaller in size as determined by rate of tree trunk growth and rate of tree top volume increases, than the large trees throughout the 15-year period and there was some indication of a tendency for the relative size differences between small and large trees to increase with increase in age of trees.

Filler trees were removed at the end of 15 years and a study of annual ring increments showed that the smallest filler tree of each row at planting time was, on the average, the smallest tree when the orchard was 15 years old and that the largest filler tree of each row at planting time was the largest at the end of the experiment.

Literature Cited

1. Bradford, F. C. and Joley, Lloyd. Causes and Effects of Size Differences in Apple Trees in the Nursery. Mich. Agr. Exp. Sta. Tech. Bul. 163. 1939.
2. Partridge, N. L. and Veatch, J. O. Fertilizers and Soils in Relation to Concord Grapes in Southwestern Michigan. Mich. Agr. Exp. Sta. Tech. Bul. 114. 1931.
3. Sax, Karl and Gowen, John W. The Cause and Permanence of Size Differences in Apple Trees. Maine Agr. Exp. Sta. Bul. 310. 1923.
4. Tukey, H. B. and Brase, Karl D. Correlation Studies of the Growth of Apple and Cherry Trees in the Nursery from the Seedling to the Two-year Budded Tree. N. Y. State Agr. Exp. Sta. Tech. Bul. 185. 1931.

SPRAY TRIALS ON ORNAMENTAL RED CEDARS

F. C. STRONG AND E. J. RASMUSSEN
SECTIONS OF BOTANY AND HORTICULTURE

The cedar-apple and cedar-hawthorn rust diseases caused by *Gymnosporangium spp.* are becoming of increasing importance in commercial ornamental tree nurseries and on public and private grounds such as parks, cemeteries, estates, where susceptible species and varieties of crab-apple, flowering apple and hawthorns are planted in close proximity to susceptible varieties of the red cedar. The close association of these two alternate host groups of the cedar-apple and cedar-hawthorn rust fungi permits the increase in number of infections year after year until these trees become very unsightly and considerable injury results.

These rusts can best be controlled by removal of one of the host groups, preferably the red cedar, *Juniperus virginiana* and its susceptible varieties to a distance of one mile from pomaceous host trees. While this practice is applicable with orchard trees, it encounters difficulties when applied to the landscaping of grounds for ornamental purposes. A nurseryman who grows both red cedars and ornamental apples and hawthorns often finds it impossible because of lack of sufficient land to make the separation. There is also the problem of adjacent property owners who may be growing one or the other of the alternate host groups.

A second method of control is the use of the more resistant varieties of flowering apples, crab apples and hawthorns and the more resistant varieties of red cedar when planting these two tree groups near to each other. Many of the favorite varieties for landscape beautification are unfortunately very susceptible to these rusts.

A third method of control is by the use of fungicidal sprays applied to one or the other or to both host groups. MacLachlan and Crowell* have worked out a successful spray program to control these diseases in the vicinity of Boston using sulphur spray at the proper time of year on each of the respective host groups.

In preliminary trials in the vicinity of Lansing, Mich., during the summer of 1938 red cedar trees were sprayed with Dow Mike,** a wettable sulphur alone and with the three different stickers added to determine whether this sulphur compound could be used without injury to the foliage and whether these stickers were of any value in increasing the effectiveness of the sulphur spray.

The 81 red cedar trees sprayed were of the following varieties and sizes:

Juniperus virginiana	15 trees 4 to 25 feet high
Juniperus virginiana var. *Canaertii*	28 trees 3 to 8 feet high
Juniperus virginiana var. *glauca*	24 trees 3 to 6 feet high
Juniperus virginiana var. *elegantissima*	8 trees 2 to 4 feet high
Juniperus virginiana var. *Burkii*	6 trees 3 to 4 feet high

An equal number of unsprayed trees of all varieties were held as controls.

The following combinations of spray materials were used to make 100 gallons of spray:

Dow Mike sulphur 6 pounds plus soybean oil*** 1 quart.
Dow Mike sulphur 6 pounds plus soybean flour*** 3 pounds.
Dow Mike sulphur 6 pounds plus Orthex**** 1 pint.
Dow Mike sulphur 6 pounds with no sticker.

Five spray applications were made at three week intervals beginning June 15th and continuing until September 8th.

Since at least 12 months must elapse from infection before the galls become visible on the red cedar trees it is impossible to determine at this time how effective these spray treatments were in controlling infection. However injuries to foliage by these treatments may be reported.

Observations of the sprayed trees made in September and October 1938 and again in April 1939 show that the foliage of *Juniperus virginiana* var. *Burkii* was turned yellow when soybean oil was used as a sticker. A very slight amount of yellowing was apparent on two *Juniperus virginiana* var. *Canaertii* trees when sprayed with this combination. Compared with unsprayed control trees, all other combinations of Dow Mike sulphur and stickers and Dow Mike sulphur alone showed no apparent injury.

Sulphur injury is associated with high temperatures. The year 1938 was not favorable for sulphur injury as shown by the following highest

*J. D. MacLachlan and I. H. Crowell. Control of Gymnosporangium rusts by means of sulphur sprays. Jour. Arnold Arboretum **18** (2): 149-163. 1937.
**Dow Chemical Co., Midland, Mich.
***Allied Mills, Chicago, Ill.
****California Spray Chemicals Co., Richmond, Calif.

temperatures and their respective dates taken from the records of the Weather Bureau at East Lansing:

June 24th	91°F.	Aug. 5th	90°F.
July 7th	89°F.	Aug. 14th	90°F.
Aug. 2d	90°F.	Sept. 12th	83°F.
Aug. 3d	91°F.	Sept. 26th	82°F.

Since weather conditions in 1938 were unfavorable for sulphur injury no definite conclusions can be drawn as to possible foliage injury by wettable sulphur. However it may be emphasized that soybean oil cannot be recommended as a sticker for wettable sulphur sprays on red cedar since it caused distinct injury to foliage of two varieties in this test.

SPELT EQUALS OATS FOR PIGS

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SECTION OF ANIMAL HUSBANDRY

Results from one trial indicate that winter spelt is about equal to oats for feeding pigs.

Four lots of six fall pigs each were fed to compare the feeding value of spelt with oats during the winter of 1938-39. Because of the high fibre content of both feeds, corn was added, Lot 1 receiving 50 per cent spelt and 50 per cent corn, Lot 2 receiving 25 per cent spelt and 75 per cent corn, Lot 3, 50 per cent oats and 50 per cent corn, and Lot 4, 25 per cent oats and 75 per cent corn. All lots received the same supplement which was composed of 40 pounds of tankage, 30 pounds of soybean oil meal, 20 pounds of ground high-quality alfalfa, and 10 pounds of dried skimmilk. The grains were mixed and fed in one compartment of the feeder and the supplement fed in another compartment, the pigs having free access to both. All lots had access to self-waterers and a mineral mixture made up of equal parts of steamed feeding bonemeal, finely ground limestone, and salt. Very small amounts of the mineral were taken by any of the lots.

The record of the gain, average daily ration and feed required per hundredweight of gain are given in the accompanying table.

The pigs averaged approximately 72 pounds at the beginning of the experiment, and individual pigs were taken out of the lots as fast as they reached approximately 200 pounds of weight. The pigs in Lot 1, receiving equal parts of spelt and corn, made the highest rate of gain, averaging 1.37 pounds per head daily as compared with 1.3 pounds for Lot 2, 1.21 pounds for Lot 3, and 1.28 pounds for Lot 4. Both lots fed spelt and corn consumed somewhat more supplement than did the lots fed oats and corn. Lot 4, receiving 25 per cent oats and 75 per cent corn, failed to take more supplement than did Lot 3, as one would expect, and this may account for Lot 4 not showing more efficiency in gain than Lot 3.

Table 1. Spelt versus oats for pigs.

Lot Number	1	2	3	4
Grains used (supplement was self-fed free choice in each lot)	Spelt 50% Corn 50%	Spelt 25% Corn 75%	Oats 50% Corn 50%	Oats 25% Corn 75%
Average initial weight of pigs	73 lb.	71.4 lb.	72.5 lb.	73 lb.
Average final weight of pigs	194.3	189.3	188.7	193
Average daily gain	1.37	1.30	1.21	1.28
Average daily ration:				
Grain	4.92	4.06	4.15	4.45
Supplement	1.04	1.06	.91	.9
Total	5.96	5.12	5.06	5.35
Feeds fed per 100 lb. gain:				
Ground spelt	179 lb.	78 lb.		
Ground corn	179	235	171 lb.	87 lb.
Ground oats	—	—	171	261
Supplement	76	82	75	70
Total	434 lb.	395 lb.	417 lb.	418 lb.

There was a small difference in the total amount of feed per 100 pounds of gain. The greatest amount of feed for gains was required by Lot 1, fed 50 per cent spelt and 50 per cent corn, and the smallest amount was required by Lot 2, receiving the 25 per cent spelt and 75 per cent corn in their grain mixture. The two oat-fed lots were practically the same in total feed requirements and are just about half way between the two spelt-fed lots.

If the two spelt-fed lots are averaged together and the two oat-fed lots averaged together, one determines that 129.5 pounds of spelt, 206.6 pounds of corn and 78.8 pounds of supplement, or a total of 414.9 pounds, were required for each 100 pounds of gain by the spelt-fed pigs. Practically the same amounts of feed were required by the average of the two oat-fed lots, the average requirement being 128.4 pounds of oats, 216.9 pounds of corn, 72.8 pounds of supplement, or a total of 418.1 pounds. While the difference is too small to be significant, the oat-fed lots consumed an average of 6 pounds less supplement for each 100 pounds of gain and 10 pounds more corn, which would make the cost of gain practically equal for the two groups.

The chemical analyses of the spelt and oats used in this trial were as follows:

	Moisture	Protein	Crude Fiber
Spelt	11.76%	10.25%	11.38%
Oats	11.59	10.75	11.94

STARCH RESERVES IN THE ROOTS OF PASTURED ALFALFA WHEN GROWN ALONE AND IN MIXTURES

H. C. RATHER AND C. M. HARRISON
SECTION OF FARM CROPS**

The use of alfalfa alone or in mixture with certain grasses for pasture is becoming of increasing importance in Michigan, owing largely to the lack of succulent, nutritious feed on bluegrass* pastures during the hot dry weather of July and August. However, the management of such pastures in order to obtain the most desirable returns in livestock products and in the duration of life and productivity of the pasture plants has not been fully worked out. The life of a stand of a winter hardy variety of alfalfa is associated with reserve foods, especially starch, in the roots of the alfalfa plants as they reach the dormant season in the fall.

With a view to explaining some of the complex problems involved in grazing alfalfa or alfalfa grass mixtures, several one-acre duplicate plots were laid out in 1934 at the W. K. Kellogg Farm, a branch station of the Michigan Agricultural Experiment Station, located at Augusta, Mich. More particularly the experiments dealt with: (1) the response to grazing with sheep of alfalfa seeded alone or in mixture with grasses of different growth habits and palatabilities; (2) the reaction of alfalfa plants to grazing, in comparison to hay cutting practices, particularly with reference to accumulation of starch in the roots at different periods throughout the growing season; (3) the relationship of gains or losses in weight of sheep on alfalfa or alfalfa grass mixtures to starch accumulation in the roots of the alfalfa, and (4) the period during the grazing season in which alfalfa plants store up reserve starch.

The experiment was conducted on a Bellefontaine sandy loam soil which was limed for the correction of acidity and fertilized with 250 pounds of 0-8-24 fertilizer. The set of grass mixture plots was started in the fall of 1934, by sowing the grass seed with rye and the following spring Hardigan alfalfa was sown in the rye with an alfalfa drill. In another set of straight alfalfa plots, the soil was similarly treated and the alfalfa was sown with oats in the spring of 1935.

With a plentiful supply of rainfall in 1935, the rye made a vigorous growth and was cut with a mower just after it had headed. This left considerable volunteer growth of rye which later shattered some seed. Good stands of alfalfa were obtained in all cases.

*Kentucky and Canadian bluegrass are commonly called June grass in Michigan.

**Acknowledgments are due G. A. Brown and L. H. Blakeslee, Section of Animal Husbandry, for their cooperation throughout these experiments especially as regards selection and supervision of grazing animals; also C. M. McCrary, Superintendent of the W. K. Kellogg Farm of the Michigan State College, where the trials were conducted.

Because of volunteer rye in the set of alfalfa, and alfalfa grass mixture plots, grazing was not started in the spring of 1936, as was originally planned, but all of this set of plots was allowed to grow until the alfalfa was in full bloom, at which time they were cut for hay. This eliminated all of the rye, a fair second growth developed and it was pastured during July. Because of the severe drouth of 1936, the sheep were turned off the first of August and the pastures were not grazed until late September, at which time sheep were turned on and left on until about November 1. Of the two plots of straight alfalfa which were seeded with oats, one (Plot 6) was grazed from May 15 to August 28, and then grazing was discontinued and the other (Plot 14) was grazed continuously from May 15 until October 16. These two plots were used for further comparisons between the alfalfa-grass and straight alfalfa pastures.

The seedings of reed canary grass and tall oat grass were very spotted but excellent stands of alfalfa, alfalfa-orchard grass and alfalfa-smooth brome grass were obtained. The grazing during 1936 was largely of an observational nature and it was noted that sheep preferred alfalfa to the orchard grass and during October, the alfalfa was grazed more heavily in this mixture than in any of the others.

In the spring of 1937, indications were that opportunity would be afforded to get a satisfactory comparison between alfalfa alone, alfalfa-orchard grass and alfalfa-smooth brome grass mixtures. The stands of alfalfa-tall oat and alfalfa-reed canary grass were very spotted and were left and cut as a hay crop.

In the grazing tests, sheep were used and the following procedure was adopted—

Grazing was started on May 14 and the one-acre paddocks stocked as follows: Alfalfa-orchard grass, 5 ewes and 6 lambs; alfalfa-smooth brome grass, 5 ewes and 7 lambs; straight alfalfa, 5 ewes and 6 lambs. Paddock No. 6 was grazed with 5 ewes and 5 lambs and No. 14, with 5 ewes and 6 lambs. Both No. 6 and No. 14 were straight alfalfa seedings. The sheep and lambs were weighed separately before being turned on to the pastures and each two weeks thereafter. Some variations in stocking during the season were necessary and will be noted in Table 1.

Samples of alfalfa roots were collected two weeks previous to the start of grazing and at two-week intervals thereafter, coinciding with the dates on which the sheep were weighed from all of the paddocks reported on here and likewise from an adjacent plot which was seeded in the same manner and at the same time and subjected to ordinary hay cutting practices. The root samples each of approximately 20 roots were selected only insofar as any dead roots were thrown out, otherwise they were taken from several spots in the paddock. The roots were washed immediately and small sections of the roots, taken approximately 3-4 inches from the crown, were pickled in formalin alcohol solution for further study.

Experimental Data

Whereas duplicate paddocks were used in each case, it was thought advisable in this report to use the sheep weights from the paddocks from which the alfalfa root samples were taken. However, the sheep weights from the duplicates were in close agreement.

Table 1. The gains and losses made by ewes and lambs on various pastures by weighing periods during the pasture season of 1937.

Grazing Period	Alfalfa-orchard grass mixture Plot 1				Alfalfa-smooth brome grass mixture Plot 2				Alfafla alone Plot 5				Alfalfa alone Plot 6				Alfalfa alone Fall grazed September Plot 14			
	Ewes		Lambs		Ewes		Lambs		Ewes		Lambs		Ewes		Lambs		Ewes		Lambs	
	No.	Gain	No.	Gain	No.	Gain	No.	Gain	No.	Gain	No.	Gain	No.	Gain	No.	Gain	No.	Gain	No.	Gain
May 14-May 28	5	65	6	74	5	90	7	95	5	47	6	78	5	47	5	34	5	33	6	49
May 28-June 11	5	41	6	70	5	28	7	96	5	32	6	45	5	18	5	36	5	26	6	48
June 11-June 25	5	−66	6	2	4	−41	7	−45	5	−55	6	9	5	−28	5	16	5	−40	6	17
June 25-July 9	6	19	7	26	6	17	7	32	6	−4	7	11	5	2	5	42	5	11	6	42
July 9-July 23	6	−9	7	−2	6	8	7	20	6	32	6	15	5	4	5	7	5	18	6	10
July 23-Aug. 6	6	−5	7	8	6	9	7	34	6	−9	6	5	5	50	5	42	5	25	6	30
Aug. 6-Aug. 20	7	−15	5	1	6	−28	5	−8	6	−22	7	−14	5	−36	5	−3	5	−26	6	9
Aug. 20-Sept. 1	7	1	–	—	6	−3	–	—	6	20	–	—	7	−13	–	—	8	−29	–	—
Sept. 1-Sept. 17	–	—	–	—	–	—	–	—	–	—	–	—	–	—	–	—	8	5	–	—
Sept. 17-Oct. 1	–	—	–	—	–	—	–	—	–	—	–	—	–	—	–	—	8	−14	–	—
Sept. 24-Oct. 8	4	66	–	—	4	81	–	—	4	40	–	—	4	−42	–	—	–	—	–	—
Oct. 8-Oct. 24	4	2	–	—	4	2	–	—	4	1	–	—	–	—	–	—	–	—	–	—
Total ewe and lamb gains per acre		99		179		163		224		82		149		2		174		9		205
Total sheep days	1,057				1,039				1,032				854				1,120			
Total gain per acre				278				387				231				176				214

A study of Table 1 shows that, as a whole, ewes and lambs both gained the fastest during the first month of pasturing. During this period, the alfalfa was succulent and growing much faster than the sheep could consume the forage. During the third grazing period from June 11 to 25, the sheep, especially the mature ewes, lost considerable weight. The forage at this time was apparently in very good condition but observations on the mechanics of weighing sheep during all sorts of weather indicate that if the weighing is done just following or during a heavy rain the mature sheep as a rule lose weight rather than gain. This may account for the losses indicated on the June 25 weighing date for it rained over an inch the night and morning previous

Fig. 1. Photograph taken on July 20, 1937, showing alfalfa-brome grass mixture on the left and alfalfa-orchard grass on the right.

to weighing. On July 9, all the lots of sheep, both ewes and lambs, gained weight with the exception of the ewes on the straight alfalfa in plot 5. In all cases the lambs gained much more than the ewes during this two-week period. The following two-week period ending on July 23, brings out a point of interest. Both ewes and lambs lost on the alfalfa-orchard grass plot, while all of the rest of the paddocks were contributing gains in sheep weights. There was considerable orchard grass left on this plot on July 23, but it was headed out, mature and unpalatable as compared with the alfalfa. In this same paddock the alfalfa was scarcely noticeable because of extremely close grazing. The alfalfa-smooth brome plot was about 8-10 inches high at this time and grass and alfalfa were both grazed at the same level. Figure 1 shows this comparison on June 20, 1937. On August 6, the sheep on

plot 5 of straight alfalfa were beginning to show the effects of a lack of feed. The sheep on the alfalfa-orchard plots had considerable feed left but it was unpalatable and gains were slight. The alfalfa-brome plot was still contributing sufficient nutritious feed for gains as were plots 6 and 14, comprised of straight alfalfa, but the latter two plots were not stocked so heavily as was plot 5, also straight alfalfa. It was noticeable at this time also that plot 6 of straight alfalfa was almost a pure stand of alfalfa, while 14, which was grazed during September the previous fall, was beginning to show a considerable number of bluegrass patches. Plot 5 was becoming very weedy, the weeds being chiefly annual in nature such as ragweed and the annual foxtails.

On August 20, practically all of the lots of sheep lost weight, the ewes showing far heavier losses than the lambs. The succulent feed was becoming scarce at this time in all paddocks, and again rainfall was probably a complicating factor, as it rained 0.42 inch the morning of August 20. On August 20, the lambs were weaned and the ewes left on the paddocks. By September 1, the alfalfa-orchard grass paddock was beginning to grow seedling orchard grass plants from shattered seed and the sheep were grazing this growth, which may explain the fact that they held their weight on this plot. The brome-alfalfa pasture was beginning new growth from rains totaling 4.55 inches on the 17th, 20th and 21st of August and the ewes lost very little. The annual weeds in plot 5 apparently were providing additional feed in this paddock as the sheep made fair gains; whereas on plots 14 and 6, the losses were considerable. The crown buds on the alfalfa plants were just emerging at this time and it was thought that possibly the new growth consisting almost entirely of alfalfa was too succulent and laxative to permit the sheep to gain in weight at this time. The paddocks with the exception of plot 14 which was grazed straight through until October 1, were rested from September 1 until September 24, at which time 4 ewes were put on each plot. During the two-week period from September 24 to October 8 the sheep made good gains on the alfalfa-orchard and the alfalfa-smooth brome grass plots and the weedy alfalfa plot (No. 5). No. 6, however, which was a far better plot as regards stand of alfalfa, produced a considerable loss. This point was noticeable on other plots not in the present test and as a general observation during the fall grazing period alfalfa grass produced the best gains, poor alfalfa (weedy or grassy) produced fair gains, and in many cases, good clean stands of straight alfalfa produced losses. The sheep were turned off of plot 6 on October 8, but grazing was continued on plots 1, 3, and 5 until October 22. There was very little change in the weight of the sheep during this last period. In summarizing Table 1, the net gains and sheep days per acre for the different paddocks were as follows: alfalfa-orchard grass, 1,057 sheep days and 278 pounds gain; alfalfa and smooth brome grass, 1,039 sheep days and 387 pounds gain; plot 5 (alfalfa), 1,032 sheep days and 231 pounds gain; plot 6 (alfalfa), 854 sheep days and 176 pounds gain, and plot 14 (alfalfa), 1,120 sheep days and 214 pounds gain.

The relative gains made by ewes and their lambs on alfalfa, alfalfa-brome grass, and alfalfa-orchard grass pastures are illustrated in the graphs presented in Fig. 2. Under this particular system of grazing

management involving continuous grazing by a uniform number of sheep from spring to September 1, the pastures are undergrazed when growth is most rapid in May and June. The excess herbage thus accumulated is grazed off in July and August when plant growth is less rapid. It should be remembered, however, that summer growth of these crops when pastured is greater when the spring production has never been grazed off closer than 8 or 10 inches than had it been eaten to within 2 or 3 inches of the ground.

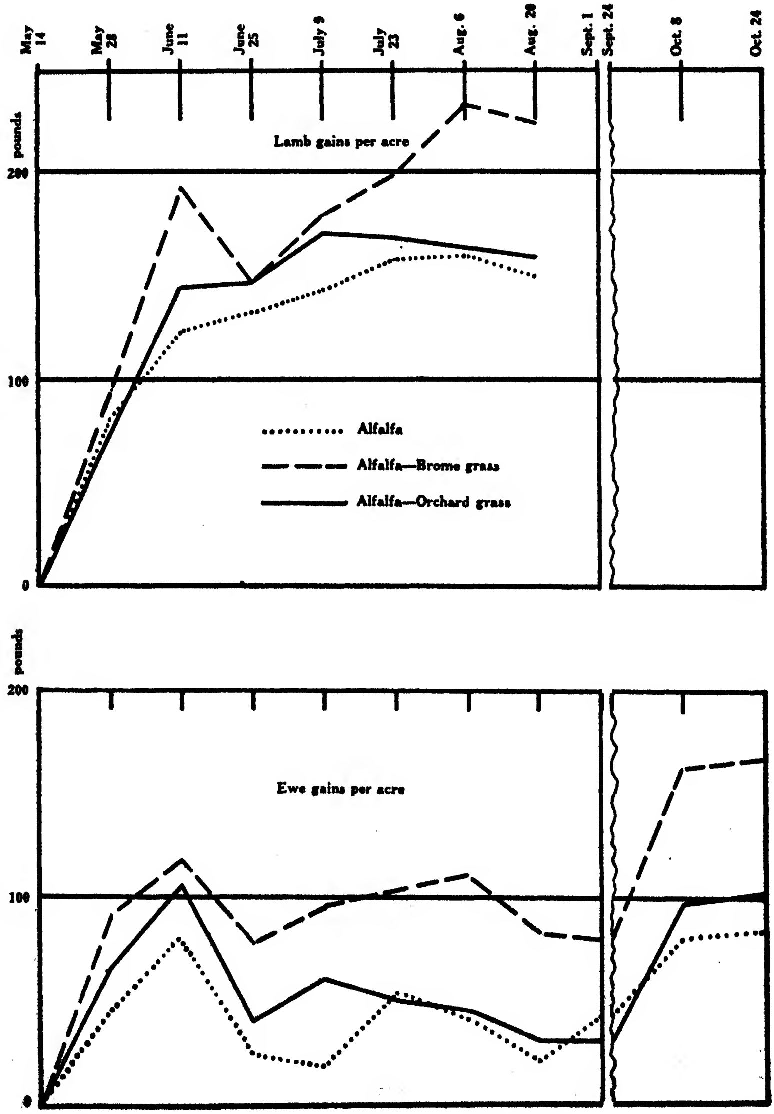

Fig. 2. Charts showing the relative bi-weekly gains made by ewes and lambs on straight alfalfa, alfalfa-brome grass and alfalfa-orchard grass pastures. W. K. Kellogg Farm trials, 1937.

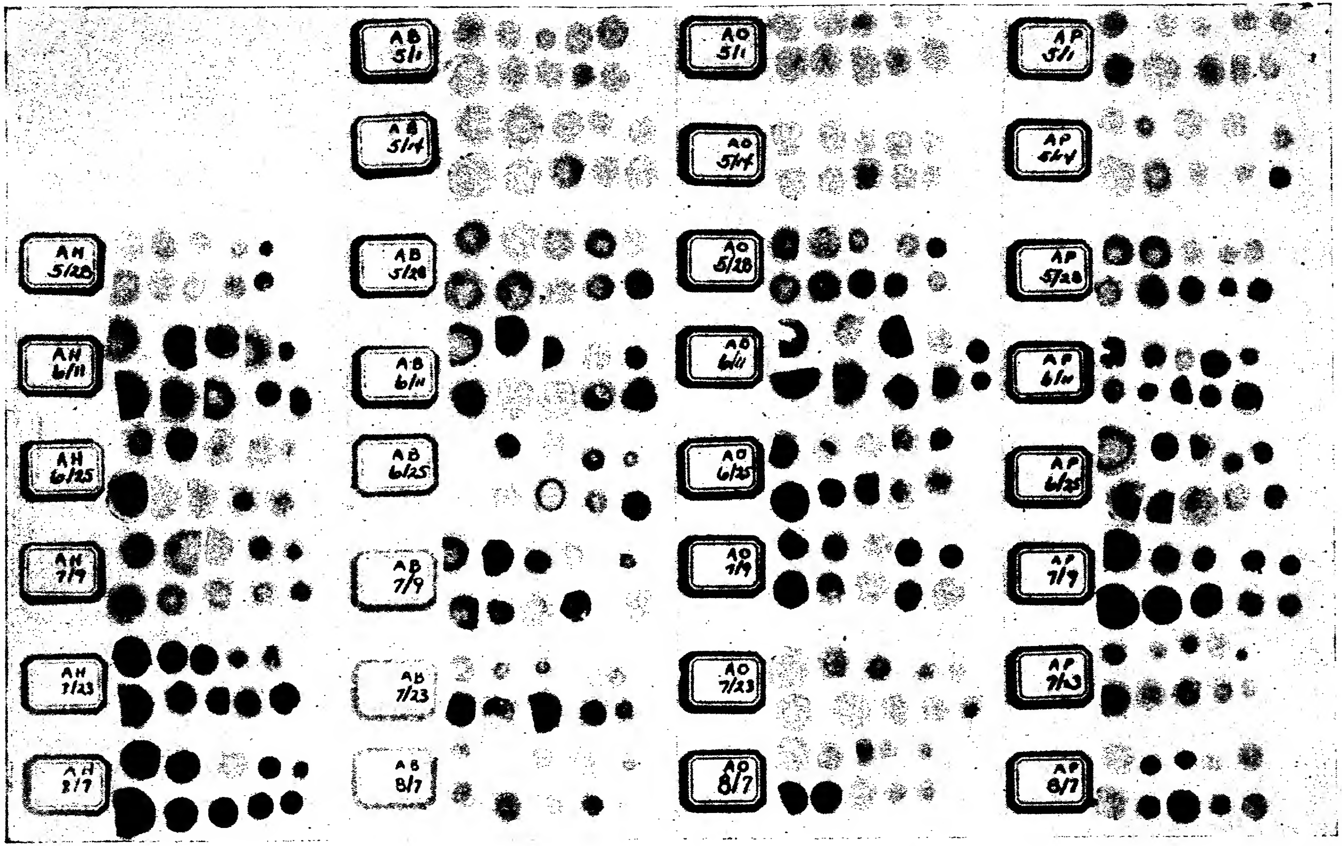

Fig. 3. Part 1—alfalfa roots showing accumulation of starch on the dates indicated. Alfalfa hay (A. H.), a pasture of alfalfa-brome grass mixture (A. B.), a pasture of alfalfa orchard grass mixture (A. O.), and alfalfa alone for pasture (A. P.).

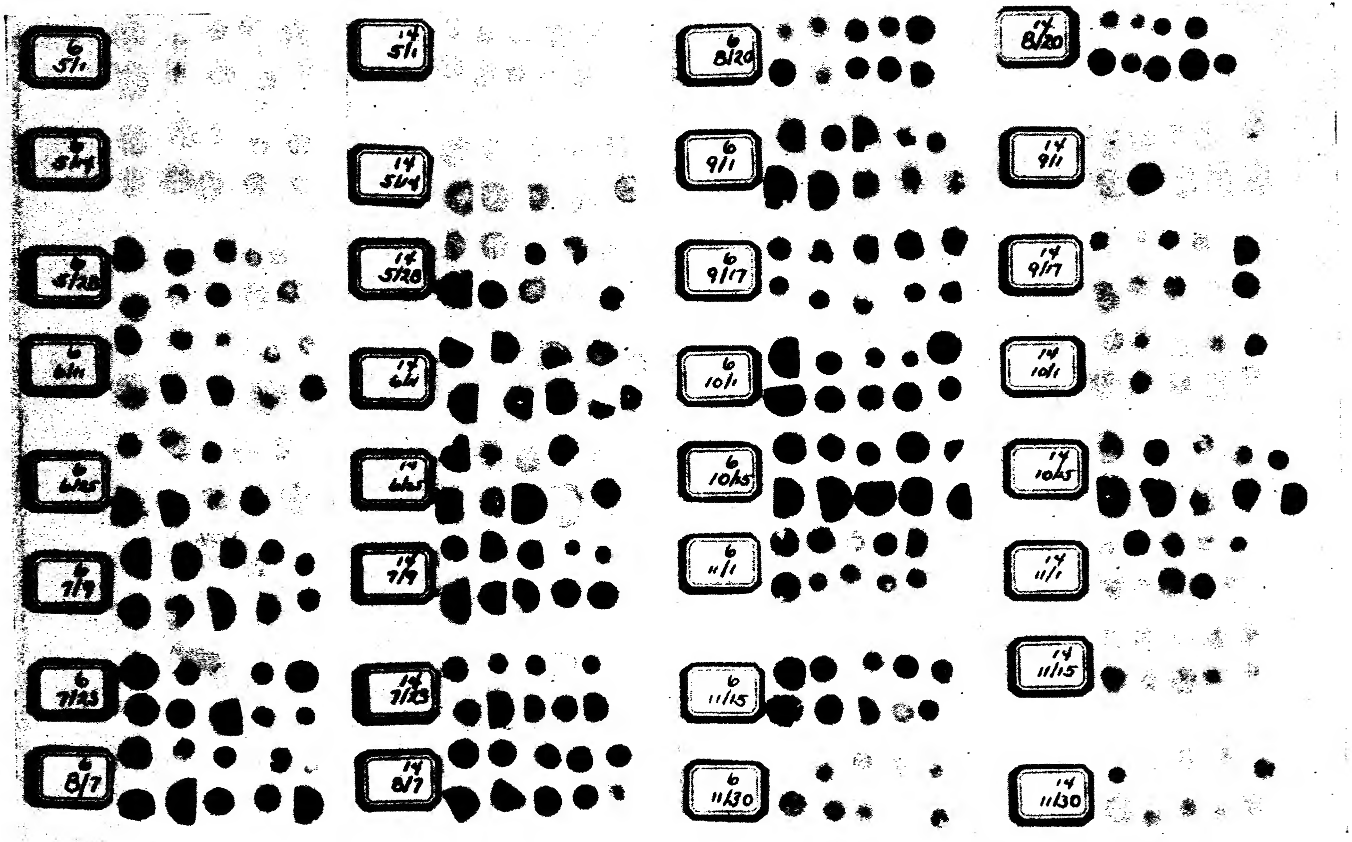

Fig. 4. Roots from plots 6 and 14 on collection dates as indicated. Note the difference in starch accumulation of the roots from the two plots from September 1 to November 30.

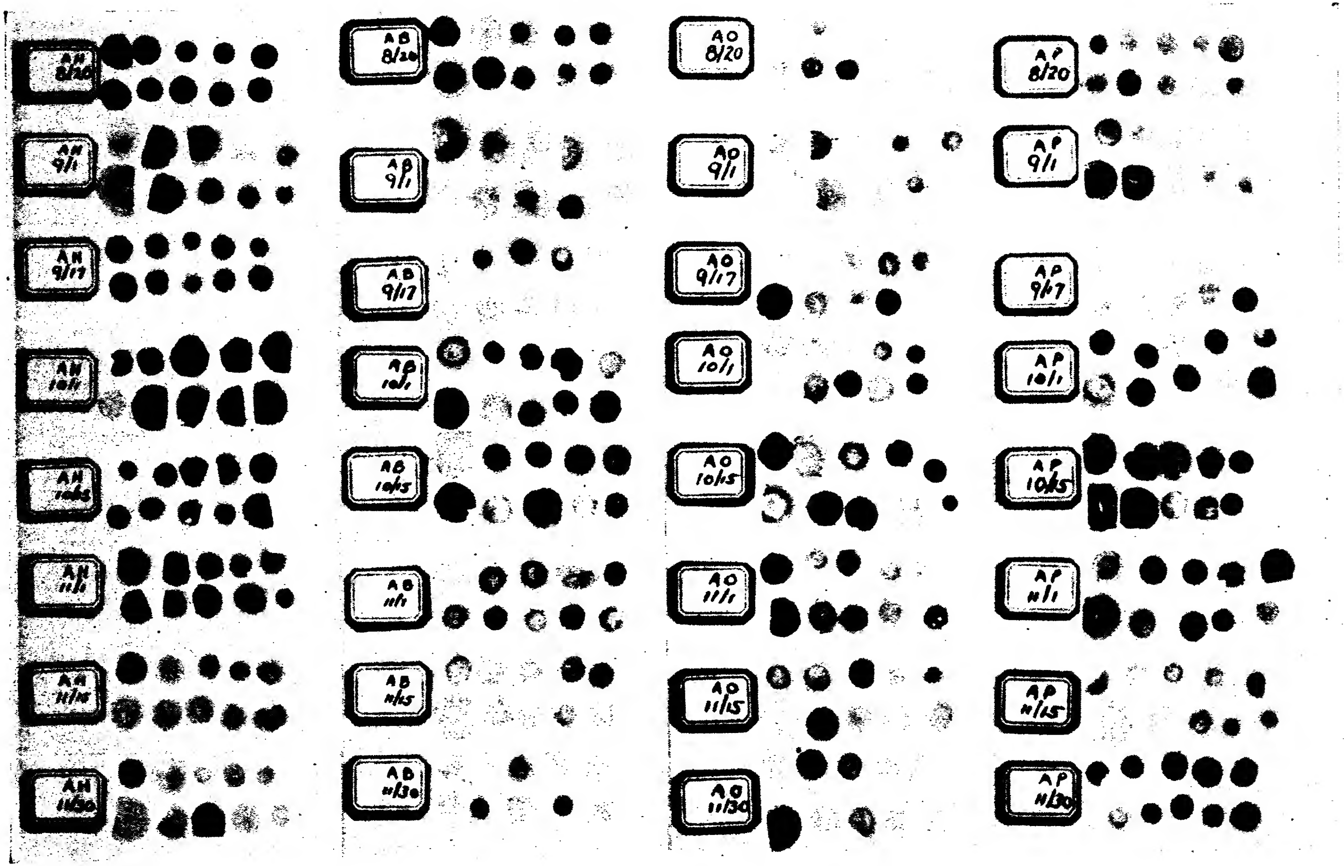

Fig. 3. Part 2—a continuation of Part 1, but at later collection dates.

In all cases the early gains were most rapid with both ewes and lambs. In the case of the mature ewes this may have been due at least in part to relatively low weights as the ewes came through the winter, the average weight of the mature Shropshires used in these trials being 112 pounds May 14. Since the lambs likewise made most rapid gains during this period, the abundance of highly nutritious herbage during this period also was an important factor.

As the season progressed, the ewes on both straight alfalfa and alfalfa-orchard grass lost weight as compared with their condition June 11, but they were maintained in somewhat better condition than they were on May 14 when first turned onto these pastures. The ewes on the alfalfa-brome mixture maintained their maximum condition until both the alfalfa and brome grass began to run short near September 1.

The lambs made their best gains on the alfalfa-brome grass both individually and as a group. On the alfalfa-orchard grass, gains were negligible after July 9, evidently because all of the alfalfa had been consumed, the ewes had dried up and the accumulated growth of orchard grass was both unpalatable and lacking in nutritive value.

The total acre gains for the season made on the alfalfa-brome grass (224 pounds by the lambs plus 163 by the ewes) were very good. If valued at 9¢ a pound for the lambs and 4¢ for the ewes, the pasture gains amount to a gross value of $26.68. However, even on this pasture the lambs weighed only 68 pounds each by August 20. Whether another type of pasture management, such as providing lambs with second growth alfalfa-brome pasture, will induce still more rapid gains or whether supplementary grain feeding will be essential presents a problem for further study.

It was apparent that all pastures with the exception of plot 6 (straight alfalfa) had been grazed fairly hard and little feed was left. On plot 6 approximately 6-8 inches of growth remained when the sheep were taken off. Approximately 200 more sheep days pasture were obtained from 1, 2, 5, and 14 than from plot 6. Table 1 and the foregoing observations indicate the nature of the gains made by sheep on the various pastures. It remains to be shown how the pasture plants reacted to the sheep grazing.

It was thought possible that the alfalfa roots previously dug from the various pastures at two-week intervals from May 1 until December 1, might show differences in starch reserves when compared with alfalfa roots collected from a field which was cut for hay. The roots which had been pickled in alcohol were dehydrated, embedded in paraffin, sectioned on a microtome and 10 individual sections each from different roots, but collected from the same paddock, were placed as a sample on a glass slide. The roots were stained with Gram's iodine to detect starch storage. Photographs of the roots were taken, without enlargement and are shown in Figs. 2 and 3. Owing to the large number of individual roots and the differences between roots of a sample it was thought advisable to show all roots, though small, rather than attempt to select a representative one and enlarge it as was done in a previous bulletin (1). No roots were collected from the alfalfa hay plot on May 1 and May 14 because grazing did not begin on any of the plots until May 14 and the first two collections from any treatment were identical to the hay plots as they all had been treated similarly in 1936.

It will be noted from a study of Figs. 3 and 4 that the alfalfa did not have much reserve starch on either May 1 or 15, whereas on May 28, all roots show an increase in starch reserves. An occasional plant was grazed short in the pastures and shows up in the series of root sections as light in color because of an absence of starch owing generally to a lack of sufficient photosynthetic tissue for manufacture of reserve carbohydrates. By June 11 considerable variation is shown between the hay plot and the pasture plots. Considerably more starch was noticeable in the roots from the hay plot than from any of the pasture plots. The hay plot was cut June 18 and the roots collected on June 25 show a depletion in starch as compared with the roots collected two weeks earlier and previous to removal of the hay crop. On July 9 there was a slight building up of starch reserves in the roots of the alfalfa from this plot and on July 23 they appeared to be again well supplied with starch reserves. In the pasture plots it was apparent that alfalfa plants when in combination with grasses did not store starch reserves so readily as when the alfalfa was not in association with a grass. Brome grass grows faster in early spring and summer than does alfalfa; consequently, shading adds another factor tending to prevent carbohydrate manufacture by the alfalfa. Orchard grass does not start so fast in the spring as brome grass, is much more susceptible to frost injury than brome and consequently does not prevent starch accumulation in the alfalfa roots to such an extent as brome grass at this same period.

On July 7 the roots from the straight alfalfa pastures (plots 5, 6, and 14) showed considerable starch reserves; all from the alfalfa-brome grass plot had some accumulated starch, but at a lower level, while about a third of the roots from the orchard grass-alfalfa were completely depleted and the others fairly well supplied. On July 23 the starch reserves in the roots collected from the alfalfa-orchard grass plot were at a very low level in comparison with those collected from the straight alfalfa plots and alfalfa-smooth brome grass plots. It may be explained again that on this date, the sheep lost weight on the alfalfa-orchard grass plot and gained on all the others and also that the orchard grass was tall, abundant and mature while the alfalfa in with the orchard grass was grazed at less than one inch in height with the exception of occasional plants which the sheep failed to eat.

By August 20 the roots from the hay plot had accumulated a high level of starch reserves; the roots from the alfalfa-brome grass paddock were higher in starch accumulation than they were a month previous, those from the alfalfa-orchard grass plot showed no replenishment, while the roots from the straight alfalfa plots were in about the same condition as they were a month earlier. The hay plot was cut the second time on August 23. There was an apparent drop in starch reserves in the roots first collected following the cutting, but a rapid recovery up to October 1, after which there was a gradual depletion brought about largely by intermittent growth periods of short duration followed by killing freezes, preventing replenishment of starch in the roots. The roots from the alfalfa-grass mixture plots never reached so high an accumulation of starch as did those from the alfalfa hay or alfalfa pasture plots.

The roots from plots 6 and 14 show a significant difference from September 1, until the last collections were made. Plot 14 was grazed

during September and grazed short. Plot 6 was the lightest grazed of all plots and was not pastured from the first to the twenty-fourth of September. The roots from plot 14 were depleted far more by September 1 than those from plot 6, chiefly because bluegrass had taken over considerable areas in plot 14 and in late summer the alfalfa in this plot was over-grazed because of the non-productiveness of the bluegrass. As a result of the September grazing on plot 14, the plants had no period in which to grow and accumulate reserve starch in their roots before freezing weather. It was apparent that the roots from plot 6 had accumulated as much, if not more, starch than any of the other plots, even including the hay plot.

It was apparent from observations in the fall, when grazing was discontinued, that the alfalfa in all of the plots with the exception of plot 6 had been over-grazed and that serious winter-killing would result. In the spring of 1938, it was estimated that there had been almost a 100 per cent killing out of the alfalfa plants in the alfalfa-orchard grass plot, and only 25-30 per cent of the plants were left in the alfalfa-smooth brome plot and alfalfa plots 5 and 14. There was apparently no damage to the stand in plot 6.

Discussion

One of the difficult questions to answer in pasture management is that regarding carrying capacity, owing to the wide range of pasture types and response of pasture plants to environment. Again there are two problems in management: First, what happens to the livestock on a given pasture and, second, what happens to the plants in the pasture as a result of grazing. As a general consideration, most pastures in Michigan do not permit close grazing or attempting to graze off all of the forage which grows in a given period. A reserve supply of forage must be left on the pasture which may be utilized during the summer period when new growth is not sufficient for the grazing animal. Close grazing of alfalfa during the first part of May when the roots of the plants are completely lacking in reserve starch results in weakening, if not actually killing, of the plants. The plants would then be slow to recover and volume of growth would be lessened. However, it is possible to stock a pasture in such a manner that the livestock can remove only a small percentage of the growth, leaving a reserve supply of herbage which, if palatable and nutritious, will be eaten in advanced stages of maturity. In this way the plants are protected somewhat until reserves are built up and the animals likewise have a reserve supply of forage. Growth of alfalfa or smooth brome grass, the most drouth-resistant of our pasture plants in Michigan, is slowed up considerably during July and August, owing to hot, dry weather and it is during this period that the reserve supply of feed is eaten. Orchard grass was apparently unpalatable at late stages of growth in comparison to the alfalfa or brome grass and as a consequence, the alfalfa was grazed extremely heavy and resulted in a loss of the alfalfa stand, whereas the orchard grass thrived because of the differential grazing. Alfalfa, in order to survive in a mixture must be sown with a grass which is at least as palatable as, if not more palatable, than the alfalfa. On mixtures of alfalfa and smooth brome grass, livestock tend to graze from the top down and because of this

habit of grazing, it is possible to manage the pasture by removing the animals when grazing has reached a certain point or to so stock the pasture that a reserve supply of plant material is left at the end of the season.

It has been found (2, 3) that alfalfa and smooth brome grass both become weakened when cut at low levels continuously and at frequent intervals. The plants produce less new growth when cut at a level of one inch than when cut to a level of six inches. The photosynthetic tissue left below the height of cutting allows for recovery growth without a storage supply of starch and aids materially in keeping the reserve supply of starch in the roots at a high level during early fall, reducing the losses due to carbohydrate starvation and consequent winter-killing.

Although the pastures in this experiment were over-grazed with the exception of plot 6, a pasture of smooth brome grass and alfalfa has been used as a dairy pasture at the Kellog Farm for 3 years with very little loss of plant stands of either alfalfa or smooth brome grass. These pastures have been stocked with milking dairy cows for the last two years at one and one-half cows per acre from May 15 to September 1, at which time the cows have eaten all but 6-8 inches of the accumulated growth. In this manner of grazing the plants have sufficient top growth and time to replenish starch reserves in their roots previous to the advent of killing frosts.

In experiments with sheep over a 3-year period on native bluegrass pastures, it has been found that if the grazing was carried on, on a season long basis, the sheep rarely showed a net gain in excess of 100 pounds per acre and very frequently much less. During the year in which this experiment was conducted, for instance, a straight orchard grass pasture similarly fertilized produced a net gain for the season of only 59 pounds. The gains from alfalfa or alfalfa grass mixtures were far greater than this and usually pay well for the added expense and trouble in providing for this type of pasture.

The continued removal of practically all of the photosynthetic tissue of a plant, that is low in reserves, reacts unfavorably in weakening the plant, cutting down on the volume of new growth and also prevents replenishment of carbohydrate reserves in the plants. Consequently, it seems feasible to assume that a certain amount of leaf tissue should be left at all times or the complete removal of tissue should come at a time when the plants have sufficient reserve carbohydrates to initiate new growth. This new growth should not be removed completely until the reserves are replenished, and care must be exercised in grazing or cutting in the period approximately one month just prior to severe freezing weather.

Summary

In a study of ewe and lamb gains during the pasture season and a bi-weekly examination of alfalfa roots for starch reserves, the following observations were made:

1. Sheep gains were the largest during a period in the first part of the grazing season when the forage was succulent and pasture plants were producing new forage much faster than a reasonable number of animals could graze it.

2. Alfalfa roots were lowest in starch reserves during the period of most active growth in the spring. Starch reserves become depleted with close grazing or following a close cutting.
3. Alfalfa or a mixture of alfalfa and smooth brome grass returned far greater net gains per acre with sheep than did any of the native pasture plants when compared on a season-long grazing basis.
4. Alfalfa and orchard grass mixture was a poor mixture because of the difference in palatability of the two plants and resulted in over-grazing and consequent death of the alfalfa.
5. It was possible to judge the difference in palatability of the two grasses, orchard and smooth brome grass, by the condition of the alfalfa roots at a time when the orchard grass was unpalatable in relation to the brome grass.
6. Starch reserves in alfalfa roots previous to killing frosts were necessary to prevent carbohydrate starvation of the plants and subsequent winter-killing.
7. Alfalfa, grown by itself, stored starch in the roots much more readily than did alfalfa when grown in a mixture with grass.

Literature Cited

1. Rather, H. C., and Harrison, C. M. Alfalfa Management with Special Reference to Fall Treatment. Mich. Agr. Exp. Sta. Spec. Bul. 292. May, 1938.
2. Harrison, C. M., and Hodgson, C. W. Response of Certain Perennial Grasses to Cutting Treatments. Jour. Amer. Soc. Agron., Vol. 31, No. 5, 1939.
3. Harrison, C. M. Greenhouse Studies of the Effect of Clipping Alfalfa at Various Heights on the Production of Roots, Reserve Carbohydrates and Top Growth. Unpublished.

BASICOP AS A CHERRY SPRAY IN 1938

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Liquid lime sulphur used as a spray material for cherry leaf spot *(Coccomyces hiemalis)* again failed to control the disease in many Michigan cherry growing districts in 1938. Bordeaux mixture at higher concentrations, which has been used commercially as a spray for cherries, has given serious injury to foliage, dwarfing of fruit and stunting of trees, thus limiting its use under Michigan conditions. Although no other material proposed as a substitute for bordeaux mixture has been found to be its equal in fungicidal efficiency and adhesiveness, several of the new proprietary copper compounds have adequately controlled the disease and have caused distinctly less injury.

Observations and experiments during 1937 on Basicop, one of the proprietary copper compounds, indicated, as previously reported by

Cation and Robertson,[1] that concentrations of Basicop and lime at 3-8-100 satisfactorily controlled the disease and gave no perceptible injury. However, unsatisfactory results were obtained owing to foliage injury when Basicop was used alone or in combination with one pound of lime or less to 100 gallons of water. Concentrations of Basicop used as low as 1½-100 gave unsatisfactory control of the disease although these plats retained distinctly more foliage than did plats treated with liquid lime sulphur 2½-100. Dwarfing of the fruit was especially severe on those plats treated with bordeaux mixture 6-8-100. Continuations of these experiments and observations were made during 1938. This article is a preliminary report of the results obtained.

Experiments

The experimental plats of 1938 were again located at the Roach Orchards, Hart, Michigan. Montmorency cherry trees that were about nine years of age were used in these experiments. Conditions were very favorable for severe attacks of leaf spot in the vicinity although destruction of the old leaves by sheet erosion of the soil and early cultivation eliminated much of the initial inoculum in the experimental block. The trees in the experimental block were seriously weakened as a result of leaf spot infection the previous year. This afforded excellent opportunity to determine the injuriousness of the various treatments because trees with a lowered vitality are much more susceptible to spray injury than strongly growing and vigorous trees.

Only a few (Table 1) of the numerous experimental treatments will be discussed in this article. Each plat in the experimental block included 9-12 trees. Those plats with a four-spray program received the petal-fall application on May 10, the two-weeks application on May 27, the four-weeks spray on June 16, and the after-harvest spray on August 6.

Table 1. Some spray materials and concentrations used in experiments at Roach Orchards, Hart, Mich., 1938.*

Basicop—lime	2–4 –100
Basicop—lime	3–6 –100
Basicop—lime	3–8 –100
Basicop—zinc sulphate—lime	2– 1–1½–100
Basicop—zinc sulphate—lime	2– ¼–4 –100
Bordeaux mixture	6–8 –100
Cupro K	3 –100
Liquid lime sulphur	2½–100

*Lead arsenate was included in the two-weeks spray and four-weeks spray of all treatments.

Although the period of full-bloom was exceptionally early (May 2-9), the first leaf spot lesions were not noted until May 31 on the untreated control trees or in other orchards examined in Oceana County. Observations and microscopical examinations indicated that the first primary infections occurred on May 20, 25 and 27. The rainfall in inches on these dates was 1.49, 0.10 and 0.93, respectively, while the mean temperatures were 55, 51, and 66 degrees F. Numerous secondary infections began to occur about June 1-2 resulting in the first

[1]Cation and Robertson. Basicop as a cherry spray. Mich. Agr. Exp. Sta. Quart. Bul. 20: 199-210. 1938.

yellowing and defoliation on June 12. An abnormal amount of rainfall throughout the latter part of May and during June, combined with comparatively warm temperatures, furnished ideal conditions for epidemic development of the disease. Successive defoliations occurred at approximately 10-day intervals during moist periods throughout the remainder of the season.

Results

Three untreated control trees in different sections of the experimental block were maintained throughout the entire season. The first infections of the season were noted on those trees, but, despite this, no defoliation due to leaf spot occurred on the trees until the harvest period (July 20-27). Defoliation was complete the latter part of August. The fact that the untreated trees were lightly infected during the pre-harvest period indicates that this orchard had a much less acute leaf spot control problem than many orchards in the immediate vicinity.

The plat treated with liquid lime sulphur received the four-spray schedule at a concentration of 2½-100. Although the foliage had many scattered infections throughout the pre-harvest period, the first serious wave of yellowing and defoliation due to leaf spot did not occur until August 5-6, just prior to the after-harvest application. The trees in this plat were defoliated completely before September 1.

There was no defoliation due to leaf spot in the experimental plats treated with bordeaux mixture at a concentration of 6-8-100. Defoliation caused by spray injury, however, was noted on these plats shortly after the harvest period and lasted until the after-harvest spray was applied. Slight amounts of injury to the foliage were also noted the latter part of September. Plats receiving a three-spray program of bordeaux mixture showed much more spray injury than did plats receiving the four-spray treatment.

Cupro K 3-100 used in a four-spray program controlled leaf spot satisfactorily. Foliage injury was first noted on this plat early in the season and was followed by several succeeding defoliations at later dates.

Results obtained in plats treated with Basicop-lime combinations closely paralleled those obtained in the 1937 experiments (1). Three-pound concentrations of Basicop in combination with 6 to 8 pounds of lime in 100 gallons of water gave adequate and satisfactory control of the disease. No noticeable injury occurred on the plats treated with Basicop 3-6-100. A slight amount of injury occurred early in the season in the plat treated with Basicop-lime 3-8-100 although no further injury was noted. The plat receiving a four-spray treatment of Basicop 2-4-100 had adequate control of leaf spot but had a slight amount of foliage injury.

Leaf spot infection was held to a minimum in plats treated with concentrations of Basicop-zinc sulphate-lime at 2-¾-4-100 and 2-1-1½-100 and there was no spray injury to the foliage. A small amount of leaf spot was noted during final data collections, October 8, on the plat which received the Basicop-zinc sulphate-lime 2-¾-4-100 spray treatment. The use of zinc sulphate in these experiments effectively prevented spray injury. These preliminary results on zinc sulphate as a preventative of injury in cherry sprays offer considerable promise and merit further investigation.

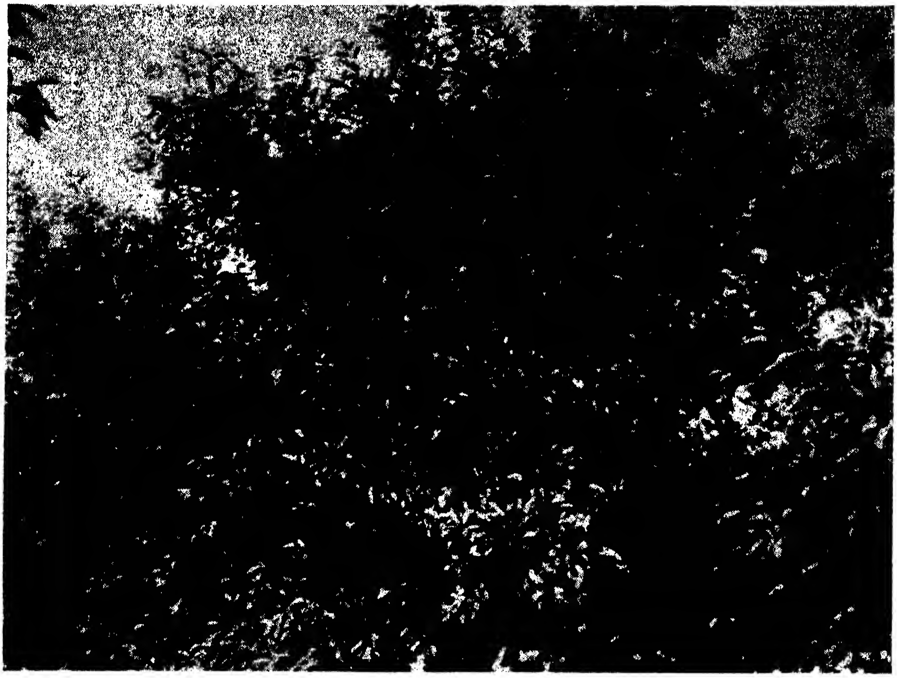

Fig. 1. Typical foliage on tree sprayed with Basicop-lime 3-6-100. Experimental plat, Roach Orchards, Hart, Mich., Oct. 8, 1938.

Reduction of fruit size caused by spray injury was not marked during 1938. The abnormally wet season tended to prevent fruit dwarfing. However, a slight reduction of fruit size occurred in certain plats treated with bordeaux mixture. Basicop, with lime or with zinc sulphate-lime, and Cupro K in comparison with liquid lime sulphur treatments caused no perceptible dwarfing of the fruit.

Summary

Results of spraying tests conducted in 1938 to compare the effects of certain spray materials as cherry sprays were essentially similar to those obtained in the experiments in 1937.

Liquid lime sulphur used at 2½-100 and following the recommended four-spray program did not give adequate control of the disease in either 1937 or 1938.

The tendency to dwarf the fruit and to injure the foliage in these experiments again indicates that a four-spray program of bordeaux mixture at 6-8-100 is unsatisfactory as a spray for cherries in Michigan.

Cupro K gave good control of leaf spot but gave severe injury to the foliage.

Basicop-lime at concentrations of 3-8-100 or 3-6-100 has given satisfactory control of the disease and little perceptible injury. Basicop used without lime or zinc sulphate-lime has been unsatisfactory because it consistently caused injury to the foliage. When used in concentra-

tions of 1½-100 Basicop has not proved adequate for the control of cherry leaf spot.

A four-spray program of Basicop-zinc sulphate-lime at 2-1-1½-100 shows definite promise as a spray for cherries. This combination in limited experiments gave adequate control of the disease and no foliage injury.

TESTS OF NEW DUST AND LIQUID FUNGICIDES IN 1938 FOR CONTROL OF CELERY LEAF BLIGHTS*

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The leaf blight diseases are perennially a serious menace to the profitable culture of celery in Michigan. With control of Fusarium yellows achieved by the development of resistant varieties, the chief problems confronting growers is control of the leaf diseases that take such a heavy toll of profits. That the problem is an acute one can be doubted by no one who has seen the effects of leaf blights in seasons like those of 1937 and 1938. The 1938 outbreak was an unusually severe one, striking destructively in the midsummer and late crops of celery, especially in the districts of intensive culture. It is doubtful if a more serious epidemic has swept over those areas in the last two decades, leaving in its wake crop failures for hundreds of growers. The effects of these diseases were quickly reflected in market conditions during August and September when prices paid to growers reached the lowest level in many years, and a more stagnant condition of the markets has probably not occurred previously. While the 1938 low prices cannot be attributed solely to the effects of leaf diseases, flooding of markets in August with blighted, low-grade celery quickly resulted in a curtailed consumer demand and a depression of prices far below those received earlier in the season. Many plantings were so badly blighted that the yields of marketable celery were insufficient to defray the costs of production. Large quantities of this low-grade celery were dumped on the markets at prices which lowered the levels established for celery of good quality.

That these diseases can be controlled well enough to prevent such losses was demonstrated in the results of dusting and spraying experiments conducted in Kalamazoo and Van Buren counties in 1935, 1936, and 1937 (2, 3, 4). Similar results have not been obtained by growers, however, and their efforts were especially unfruitful in 1938, when dusting and spraying often failed to provide a satisfactory degree of protection against leaf diseases. Many growers question the effectiveness of the fungicides commonly used to control these diseases and are constantly seeking more efficacious materials in new fungicides used successfully on other crops.

*A portion of the cost of conducting these tests was defrayed from funds provided by the Sherwin-Williams Co., Cleveland, Ohio.

The 1937 experiments with both dust and liquid fungicides provided information for comparing the fungicidal value in that season of various new materials. As explained previously (4), there is a definite need for the development of a substitute for the copper sulphate-lime dust fungicides since these dusts contain large excesses of hydrated lime. The use of such dusts year after year in districts such as Kalamazoo has resulted in creating soil conditions on many farms increasingly less favorable for the production of celery. A major objective of these experiments is the development of an efficient fungicidal dust that contains no lime or one in which the lime is not sufficient to shift soil reactions significantly when used for a period of years. The beneficial effects of sulphur were noted in the 1937 tests, and it was suggested that if it could be combined with copper compounds such a combination might be a good substitute for the copper sulphate-lime mixtures. This report is on the results obtained with such dust combinations and others not previously tested as well as on the comparative efficiencies of bordeaux mixture and some copper fungicides of low solubility.

Dusting Experiments at Comstock

Materials and Methods—In the 1937 experiments sulphur alone was not an effective fungicide for the control of celery leaf blights, but there were obvious beneficial effects from its use. The copper sulphate-lime dusts have usually given superior disease control; nevertheless, some of the newer copper materials are being used by growers in a limited way. The inclusion of talc and other inert fillers in these new dusts is a distinct advantage in most sections where the copper sulphate-lime combinations have been used for many years. It seemed, therefore, that if these low solubility copper compounds could be combined with sulphur and inert fillers, such a dust would eliminate the objectionable features of the combinations containing lime. A purely empirical formula was submitted to three manufacturers of copper fungicides with the request that they prepare dusts for use on celery to contain the following ingredients in these proportions:

Copper 7 per cent
Superfine dusting sulphur 30 per cent
Talc filler to make 100 lbs.

It was also suggested that dusts of similar composition be prepared with the addition of materials to increase the adhesive properties.

Dusts of the following composition were submitted for these tests:

Cuprocide dust No. 1*
Cuprocide (92 per cent copper) 7 lbs.
Sulphur 30 lbs.
Talc 63 lbs.

Cuprocide dust No. 2*
Cuprocide 7 lbs.
Sulphur 30 lbs.
Dry Aresket sticker 1⅔ oz.
Talc 63 lbs.

*Röhm and Haas, Philadelphia, Pa.

Bordow dust No. 1**

Bordow (40 per cent copper) 18 lbs.
Mike dusting sulphur 31 lbs.
Talc 51 lbs.

Bordow dust No. 2**

Bordow 18 lbs.
Mike dusting sulphur 31 lbs.
Bentonite 10 lbs.
Talc 41 lbs.

Basicop dust No. 1***

Basicop (50-52 per cent copper) 14 lbs.
Talc 86 lbs.

Basicop dust No. 2***

Basicop 14 lbs.
Sulphur 30 lbs.
Santomerse sticker ¼ lb.
Talc 55¾ lbs.

In addition to the commercially mixed dusts listed, the following were prepared locally:

Standard 20-80

Monohydrated copper sulphate (33 per cent copper) 20 lbs.
Hydrated spray lime 80 lbs.

20-30-50

Monohydrated copper sulphate 20 lbs.
Hydrated spray lime 30 lbs.
Talc 50 lbs.

The 20-30-50 modification of the standard 20-80 mixture was prepared with the object of retaining the effective fungicidal properties of the copper sulphate-lime mixture with the elimination of the excess of hydrated lime.

The dusting experiments were conducted on the farms of L. Knott and Lewis Wanders, Comstock, Mich. Three sets of plats were established in spaced plantings of celery for marketing in August and September. It is these plantings that are most seriously affected with leaf blights. The earliest planting, which is ready for market in late June and July, usually is not dusted because it matures early enough to escape damage from leaf diseases. Weather conditions, however, were unusually favorable for the development of leaf blights in June, and disease in the early planted celery reduced yields measurably in undusted fields. It was the exceptional development of leaf blights in the early plantings that made their control so much more difficult in the later settings. Both early blight *(Cercopora apii)* and late blight, *(Septoria apii-graveolentis)* were observed June 6 in the early plantings, and by July 1 infections were general on the bottom leaves.

On the Knott farm Basicop No. 1, Basicop No. 2, Cuprocide No. 1, Copper sulphate-lime 20-80 and the copper sulphate-lime talc 20-30-50 dusts were compared. These same dusts and Bordow No. 1 were used in the plats on the Wander farm. The treatments were replicated four times in plats consisting of 5 rows 2 rods long. The dusts were applied with hand-operated dusters at rates as nearly equal as possible,

**Dow Chemical Co., Midland, Mich.
***The Sherwin-Williams Co., Cleveland, Ohio.

but owing to differences in density and other physical properties, it was not possible to adjust the duster to discharge equivalent quantities. Thorough coverage is essential to good control and since physical properties determine to some degree the dispersion of the dust particles, those dusts with superior flowing qualities covered the foliage more thoroughly. The Cuprocide dusts were superior in flowing qualities and the uniform discharge and maximum dispersion of the particles resulted in a degree of coverage not achieved with any dusts used previously. These dusts possessed ideal properties for application in hand-operated dusters of the type used in these experiments. Basicop dust No. 2, was difficult to apply evenly owing to some property not yet determined. The discharge from the duster was irregular and the coverage of the foliage was very uneven. The 20-80 copper sulphate-lime dust did not possess good flowing qualities and the modified 20-30-50 showed no improvement in this respect.

Records—The comparative effectiveness of the dusts was determined from counts of the number of blight lesions on leaves of approximately the same age. Just before the crop was harvested a leaf from the bottom of 10 plants selected at random in every plat was removed and the number of spots counted on the two opposite leaflets just below the apex. The area of each leaflet was then measured by means of the photoelectric device developed by Hibbard, Grigsby, and Keck (1). Since each treatment was replicated four times, this entailed the taking of records of 80 leaflets for each dust used. From these data, the number of blight infections per leaflet and per unit area (cm) of the surface could be calculated. Since both surfaces of the leaflets are exposed to infection, the total surface area was twice that obtained from the reading on the photoelectric device. Because of the wide variation in the size of the leaflets from the various plats, the number of blight spots per unit area of leaflet surface gives a more accurate comparison of the effectiveness of the dusts than the number per leaflet. In general, the sizes of the leaflets were proportional to the degree of blight control. The presence of numerous infections checked the development of the leaflets and prevented their attaining normal size.

Yields records were taken at time of harvest and consisted of the net weights of the trimmed plants before they were packed into crates. The weight records in the Wanders plantings are much lower than those in the Knott plats because of injury to the plants from excessive wetness of the soil in August after the Knott plats had been harvested.

No predetermination of the number of applications required to control leaf blights can be made. Weather conditions determine not only the number of applications but also the time the dust must be applied to be most effective. The dusting was usually done shortly after daybreak or at dusk to take advantage of lulls in breezes, which, in summer, blow constantly over the marshes from about 8 a. m. to 8 p. m. Another advantage of early morning or evening dusting is the presence of moisture on the leaves from dews.

Results—In Table 1 are summarized the data on comparative blight control and yields from the plats on both the Knott and Wanders farms.

Table 1. Comparative blight control and yields in celery plats dusted with various fungicides, Comstock, Mich., 1938. Data from plats consisting of 5 rows, 2 rods long, replicated 4 times.

KNOTT FARM

Treatment	No. of Blight Spots on 80 Leaflets	Average No. Per Leaflet	Sum of Surface Areas of Leaflets, cm2	Average No. of Spots Per cm2	Yield, Net Weight Pounds	Per cent Increase in Yield Over Undusted
Cuprocide No. 1	615	7.7	4,032	0.15	1,086	57
20-80	652	8.1	3,606	0.18	1,120	62
Basicop No. 1	742	9.2	3,436	0.22	1,145	64
Basicop No. 2	995	12.4	3,698	0.27	1,078	56
Undusted	1,712	21.4	3,316	0.52	691	

Applications June 20, 24, 30, July 5, 9, 13, 16, 18, 29. Harvest August 5.

WANDERS FARM

Treatment	No. of Blight Spots on 80 Leaflets	Average No. Per Leaflet	Sum of Surface Areas of Leaflets, cm2	Average No. of Spots Per cm2	Yield, Net Weight Pounds	Per cent Increase in Yield Over Undusted
Cuprocide No. 1	516	6.4	4,146	0.12	413	32
Bordow No. 1	822	10.3	3,850	0.22	357	10
Basicop No. 2	970	12.1	3,474	0.28	361	15
20-80	1,142	14.2	3,482	0.33	330	5
20-30-50	1,137	14.2	3,340	0.34	340	8
Undusted	2,967	37.0	3,118	0.96	313	

Applications June 20, 24, 30, July 5, 9, 13, 16, 18, 23, 25, 26, Aug. 8, 11, 18, 22, 26. Harvest Sept. 1.

On the Knott farm satisfactory control of leaf blights was obtained with all the dusts used. The control was more satisfactory than the records show since most of the infections were due to the late blight fungus and the spots were small and so few they did little damage to the plant. In the undusted plats, however, the development of both early and late blights was extensive enough to cause very noticeable injury to the plants. The records show that control of leaf diseases with all the dusts resulted in very profitable increases in yields.

In no previous season since these experiments were started has any dust excelled the 20-80 copper sulphate-lime combination in fungicidal efficiency. Cuprocide No. 1 surpassed all others in effectiveness in the plats on the Knott farm and as will be seen later this superiority was also maintained in the later plantings. The 20-80 dust was slightly more effective than Basicop No. 1 which in turn gave better control than Basicop No. 2. Examination of the plants just before harvest revealed no perceptible injury from any dust. While the degree of blight control achieved with each of the dusts tested was satisfactory in this medium-early crop, leaf blights had not yet reached the peak of their destructiveness and the probable effectiveness of such dusts during periods of maximum spore dispersion later in the season, could not be predicted from the results in this planting.

The plats on the Wanders farm were not harvested until almost four weeks later. During this interim the weather was extremely favorable for leaf blights. There was considerable injury to the plants from heavy rains and flooding of the plats. The leaves became chlorotic and the plants were stunted and failed to respond to ordinary cultural methods. In this condition they appeared to be much more susceptible to infec-

tion and blight spread more rapidly. The dusts seemed to be much less effective than earlier when the plants were growing at a normal rate.

In these plats three dusts of similar composition were compared with the 20-80 and its 20-30-50 modification. Basicop No. 2, Bordow No. 1 and Cuprocide No. 1 were composed of copper materials of low solubility, sulphur, and talc. Basicop No. 2 also contained a sticking agent. Each dust contained the same quantities of copper and sulphur with a variation only in the talc content. It was expected that these three dusts would protect the plants equally well because of similarity of compositions. Each of them controlled leaf blights better than did the 20-80 or the 20-30-50, but Cuprocide No. 1 was again the most effective. Significant differences are apparent in the degree of control obtained with this dust when compared with Bordow No. 1, the second most effective one in the series. The 20-80 ranked lower than any of the dusts containing copper, sulphur, and talc and these results further strengthen the belief that these materials can be combined to form a dust fungicide superior to the copper sulphate-lime mixtures. No injury from the dusts was apparent, but this could not be determined with certainty since the plants were somewhat dwarfed and chlorotic because of soil conditions.

The greater effectiveness of Cuprocide dust No. 1 may have been correlated with better coverage of the plants owing to its smoother flowing qualities. There is some evidence for this possibility in the results of the chemical analyses for residual copper on the leaves (Table 5). The results obtained in this test were essentially similar to those from the earlier planting on the Knott farm. Their consistency under different sets of conditions when, in one case, leaf blights were comparatively easy and, in the other, difficult to control, indicates that this particular combination of materials possesses superior qualities as a fungicide for celery blight control.

The 20-80 and the 20-30-50 dusts provided about the same degree of protection which indicates that reducing the quantity of lime from 80 to 30 pounds in the 20-80 mixture did not impair the fungicidal efficiency of the copper. Since the larger quantity of lime is undesirable the inclusion of the talc as a substitute is a distinct advantage. Neither the 20-80 nor the 20-30-50 mixture has physical properties that characterizes a good dust fungicide. They do not flow smoothly or evenly from the duster and do not store well, even for short intervals. Unless used very soon after mixing or stored in moisture-proof containers they absorb water and become lumpy. Since it seems probable that some combination of insoluble copper compound, sulphur and talc, such as Cuprocide No. 1, can be prepared that will be equally effective and possess more desirable physical properties, other modifications of the 20-80 dust need not be prepared.

The low yields in these plats as compared with those on the Knott farm were due to the stunted condition of the plants because of wet soil. The comparative yields are not, therefore, so good an index of the relative fungicidal values of the dusts as they would be under more favorable growing conditions. It will be noted that the increases in yield are not always proportional to blight control. Though the plats were replicated four times slight variations in elevation in various parts of the field had a differential effect on the growth of the plants following the heavy rains in August.

Influence of Stickers on the Effectiveness of Dusts

Better control of leaf blights has generally been obtained with bordeaux mixture than with the copper sulphate-lime dusts. This has been attributed to the superior adhesive qualities of the liquid fungicide. The dust combinations are apparently quickly removed by rains so that more frequent applications are required to maintain protection. A series of plats were laid out on the Wanders farm to test the comparative effectiveness of the copper-sulphur-talc dusts with and without stickers. A sticking agent was added by the manufacturer to the Bordow, Cuprocide, and Basicop dusts, and they were compared with those containing no adhesive. Basicop No. 1 contained no sulphur, but it was used in this test to complete the series. The composition of each dust can be determined by referring to the list of materials (page 296). Only three replications could be made of each treatment owing to the number of dusts used and the arrangement of the rows. The summarized data from these plats are listed in Table 2.

Table 2. Tests of fungicidal dusts prepared with and without sticking agents for control of celery leaf blights, Wanders farm, Comstock, Mich., 1938. Plats 3 rows wide 1¾ rods long, replicated 3 times.

Treatment	Total No. of Infections on 60 Leaflets	Average No. Per Leaflet	Sum of Surface Areas of Leaflets, cm2	Average No. of Infections Per cm2	Yield, Net Weight Pounds
Cuprocide No. 1	433	7.2	3,080	0.14	220
*Cuprocide No. 2	657	10.9	2,988	0.22	200
Bordow No. 1	774	12.9	2,774	0.29	213
*Bordow No. 2	816	13.6	2,612	0.36	206
*Basicop No. 2	761	12.6	2,482	0.31	171
Basicop No. 1	935	15.7	2,612	0.36	182
Undusted	2,690	44.8	2,190	1.23	162

Applications: July 19, 23, 25, 27, Aug. 2, 8, 11, 18, 24, Sept. 2. Harvest Sept. 9.
*Contains sticker.

Injury from excessive wetness of the soil was very pronounced in these plats and is reflected in the low yields. Cuprocide No. 1 again was the most effective dust and its efficiency was not increased by the addition of Aresket sticker. The differences are great enough in the degree of control achieved with Cuprocide No. 1 and Cuprocide No. 2 to indicate that the addition of Aresket sticker decreased the fungicidal value of the dust. Adding Bentonite to Bordow dust No. 1 had no effect in shifting the efficiency of this dust in either direction. Basicop No. 2 gave slightly better control of leaf blights than No. 1, but the difference is slight. The increased fungicidal value of the No. 2 dust might be due to its sulphur content rather than to Santomerse sticker, although Basicop No. 1 gave better control in the earlier test on the Knott farm. Surveying the results in the entire series, it seems apparent that the effectiveness of a dust is determined by factors other than adhesiveness. That the addition of these sticking agents did increase the adhesiveness of each dust, is shown by the comparative quantities of copper remaining on the leaves at harvest time (Table 5).

Liquid Fungicides For Blight Control

The spraying tests were conducted on the farm of John DeFeyter and Marin Dees at Decatur. Plats were laid out in a field on which celery had been grown for several consecutive years, and in a vicinity where blight had caused serious damage to the 1937 crop. The crop sprayed was a late planting of tall strain Golden Self Blanching, and the transplanting was not completed until July 4. The rows were 55 rods long and spaced 42 inches. When this field was selected for the experimental work the drainage appeared to be adequate and the growers stated that Fusarium yellows had not affected the 1937 crop. In August, however, there was some damage from excessive wetness of the soil in some sections of the field, and during the warm and dry weather of July and early August Fusarium yellows caused dwarfing of plants in restricted areas. The materials tested and concentrations used are shown in Table 3.

Table 3. Concentrations of materials to make 100 gallons of spray for the control of celery leaf blights, Dees and DeFeyter farm, Decatur, Mich., 1938.

Basicop 4 pounds, Sherwin-Williams 81-S sticker 1 pint.
Basicop 4 pounds, lime 6 pounds, 81-S sticker 1 pint.
Basicop 4 pounds, lime 6 pounds, zinc sulphate 1 pound.
Basicop 4 pounds, lime 6 pounds, wettable sulphur 4 pounds.
Bordeaux 8-12-100 (Copper sulphate 8 pounds, lime 12 pounds.)
Bordeaux 8-6-100 (Copper sulphate 8 pounds, lime 6 pounds).
Copper A (Copper oxychloride, 45% Cu.) 4½ pounds, Grasselli sticker ½ pint.
Cuproeide 54 (Red Copper oxide, 48% Cu., and sticker) 4 pounds.

The rainfall from July 1 to August 15 was very light and blight infections were not numerous until after frequent and heavy showers occurred subsequently. From August 15 to September 15 showers were spaced favorably for the rapid spread and development of both early and late blights and by September 1 the plants in the unsprayed rows were heavily infected. At the time the last two applications were made the bottom leaves on the unsprayed plants were dead and damage was severe in these plats. After September 15 no rain fell until after the plats were harvested, and no late infections occurred even in the unsprayed rows.

The sprays were applied with a Bean power sprayer operated at 300-350 pounds pressure. For the late applications, when the plants were largest, a minimum pressure of 400 pounds would have given a much more effective coverage.

The yield records are based on data taken in a selected portion of the field where no damage occurred from water or from Fusarium yellows. A section crosswise of the plots was chosen, and the celery harvested and packed into ⅔-crates. Each plat of 2 rows 55 rods long was approximately 1/7 of an acre and the yield records were taken from ⅛ of this area in each plat. By multiplying the actual yields obtained from these small plats by 56 the yields per acre were obtained. Only by this method of sampling could a fair comparison of the effects of the fungicides on yield be obtained. Damage from water and Fusarium yellows was confined to irregular areas and the records had to be taken from a portion of the field where such damage had not occurred.

Table 4. Comparative effectiveness of liquid fungicides in the control of celery leaf blights, Dees and DeFeyter farm, Decatur, Mich., 1938. Data from duplicate plats 2 rows wide and 55 rods long.

Treatment	Total No. of Blight Infections on 100 Leaflets	Average No. Per Leaflet	Sum of Leaflet Surface Areas cm2	Average No. of Infections Per cm2 of Surface Area	Yield: 2/3-Crates Per Acre		Increase in Yield Over Unsprayed Per cent
					Jumbo Grade	Medium and Small Grades	
Bordeaux 8-12-100	138	1.38	4,802	0.03	196	210	81
Bordeaux 8-6-100	190	1.90	5,066	0.04	196	210	81
Copper A	434	4.34	4,746	0.09	140	196	50
Basicop-sticker	917	9.17	4,718	0.19	—	280*	25
Cuprocide 54	1,143	11.43	5,284	0.21	168	210	69
Basicop-lime-sulphur	1,088	10.88	4,586	0.23	112	252	62
Basicop-lime-sticker	1,315	13.10	4,622	0.28	140	224	62
Basicop-lime-zinc	1,301	13.01	4,188	0.31	56	252	37
Unsprayed	7,689	76.89	4,440	1.73	0	224†	

Applications: July 15, 19, 24, 29, Aug. 1, 15, 18, 22, 29, Sept. 3, 12, 16, 21.
*Did not receive applications of July 15 and 19. Low yields due partly to water injury. Harvested without grading; includes jumbo, medium and small sizes.
†Small sizes only.

Results—The summarized data from these plats are shown in Table 4. The bordeaux sprays controlled leaf blights so much more effectively and left the foliage in such good condition that there could be no doubt of the superiority of these mixtures over the rest of the materials used in this test. The better color and freedom from disease of the leaves in the bordeaux plats became more and more noticeable as the season advanced and leaf blights reached the peak of distructiveness. A cursory examination of the plants gave the impression of complete control of leaf blights by the bordeaux sprays. One of the bordeaux plats was immediately adjacent to one unsprayed and late in the season the leaves of plants in the adjoining rows were almost in contact. The sprayed plants were thus subjected during rains to heavy inoculations with spores of *Septoria apii-graveolentis* splashing from the badly blighted leaves in the unsprayed row. Despite such favorable conditions for infection, bordeaux mixture protected the leaves far better than did other fungicides in the rows where the plants were not exposed to such heavy inoculation. The striking contrast between the appearance of the unsprayed plants and the adjacent ones protected with bordeaux proved of special interest and a source of much comment from growers who visited the plats in late September.

Of the other copper materials, Grasselli Copper A was the most effective in blight control. Both early and late blight were controlled satisfactorily by this fungicide and it would be an acceptable substitute for bordeaux were it not for its toxic effect on the plants. This will be referred to later.

Of the four Basicop sprays, the one consisting of Basicop and sticker was the most effective. Lime, added to counteract any possible toxic effect of copper on the celery plant, not only failed to prevent this type of injury, but also decreased the effectiveness of the fungicide. The Basicop-lime-zinc and Basicop-lime-sulphur sprays were not effective combinations and controlled leaf blights much less satisfactorily than

the Basicop-sticker combinations. Cuprocide 54 was about equal to the Basicop-sticker spray in effectiveness.

The yield records show that the bordeaux plats were most productive and that the best market grades of celery came from the rows sprayed with those fungicides. All of the plants from the unsprayed rows were of the lowest grade (Hearts) and were marketed with difficulty even at very nominal prices. In contrast, almost half of the plants from the bordeaux plats went into the jumbo grade which commanded the highest prices. Taking the total number of crates as a basis for comparing yields, the bordeaux plats produced 81 per cent more than did the unsprayed rows; Cuprocide 54 ranked next with a 69-per cent increase and the Basicop-lime-sticker, Basicop-lime-sulphur combinations increased the yields in those plats by 62 per cent. Copper A plats yielded 50 per cent more than did the unsprayed rows and the Basicop-lime-zinc plats produced 37 per cent more crates than the check plats. The Basicop-sticker plats were the lowest yielding ones in this series, but this cannot be attributed to a low fungicidal index of the spray, since this combination controlled leaf blights better than the other Basicop mixtures. These plats were not included in the original plan of the experiment and did not receive the first two applications. In addition, they were in a portion of the field less favorably located than others in the Basicop series and were damaged some by water. Under more favorable conditions yields in these plats would have been higher, owing to the better blight control achieved with this spray. A factor contributing to the smaller yields in all the plats sprayed with the copper materials of low solubility was the toxic effects of these sprays on the celery plant.

Copper Injury—During July and August no pronounced differences in color of the foliage could be detected on the plants in the various plats. In September, however, with the advent of lower mean temperatures, the plants sprayed with the low solubility copper materials showed evidence of injury in a yellowing of the leaves. In late September this condition of the foliage was very noticeable even from a distance, and was in strong contrast to the dark green color of the plants in the bordeaux plats. A similar condition had been observed in 1937 in the plats sprayed with similar copper fungicides. The chlorotic condition of the plants then was not attributed solely to the effect of the sprays, since the plats had been flooded and the yellowing of the leaves was assumed to be a response to that factor. Neither lime nor zinc sulphate added to the Basicop sprays decreased the injury, since the chlorosis was just as severe in the plants sprayed with these combinations as in those sprayed with Basicop and sticker only.

Reducing by half the amount of lime in bordeaux mixture did not cause any injury to the plants; those sprayed with a 8-6-100 mixture were just as dark green as those in the 8-12-100 plats. Some observers believed that the color of the plants sprayed with the 8-6-100 bordeaux was better than those protected with the standard mixture containing 12 pounds of lime. The differences were slight and if any existed they could not be detected with certainty from a casual examination of the plants.

Residual Copper on Leaves—Leaf samples for determination of residual copper were collected just before harvest from the dusted

Table 5. Residual copper on celery leaflets dusted or sprayed with various fungicides, 1938.

Treatment	Total Mg. Cu. in Sample	Mg. of Cu. Per cm2 of Leaflet Surface Area	Effectiveness in Blight Control. Rank:
Dusted Plats, Series No. 1, Wanders Farm, Comstock, Mich.			
Cuprocide No. 1	0.238	0.0043	1
20-30-50	0.204	0.0036	5
Basicop No. 2	0.199	0.0035	3
Bordow No. 1	0.103	0.0018	2
20-80	0.043	0.0008	4
Series 2, Wanders Farm			
Cuprocide No. 2	0.288	0.0068	2
Cuprocide No. 1	0.234	0.0056	1
Basicop No. 2	0.155	0.0037	5
Basicop No. 1	0.116	0.0028	6
Bordow No. 2	0.057	0.0013	4
Bordow No. 1	0.052	0.0012	3
Sprayed Plats, Dees and DeFeyter Farm, Decatur, Mich.			
Bordeaux 8-6-100	2.66	0.0169	2
Bordeaux 8-12-100	2.22	0.0141	1
Cuprocide 54	1.65	0.010	5
Basicop-sticker	1.55	0.0098	4
Basicop-lime-zinc	1.43	0.0091	8
Basicop-lime-sticker	1.26	0.0082	7
Basicop-lime-sulphur	1.24	0.0078	6
Copper-A-sticker	0.67	0.0043	3

plats on the Wanders farm and from the sprayed plats at Decatur. A leaf punch 0.6 cm in diameter was used for taking a single disk of tissue from 25 plants selected at random in each plat in the dusted series at Comstock. At Decatur a punch 1.0 cm in diameter was used and a single disk was taken from 50 plants in every plat. The disks were taken from bottom leaves of approximately the same age. The results of analyses of these samples for copper are given in Table 5.

In the two series of dusted plats on the Wanders farm Cuprocide dusts left heavier residues of copper on the leaflets than the other materials. The superior coverage achieved with these dusts may account for the heavier loads of residual copper on the plants. In each of the series of dusted plats Cuprocide dusts also gave the best control of leaf blights. There is little direct correlation, however, between the amounts of residual copper on the leaflets and comparative effectiveness of the other dusts in these series. Thus the 20-30-50 dust ranked fifth in effectiveness but second in residual copper on the leaflets. The chemical nature of the residual copper is apparently of more importance than the quantity.

The addition of stricking agents increased the adherence of the copper-sulphur-talc dusts, but a direct correlation between copper residue on leaves and effective control of leaf blights did not extend through the series. The Cuprocide dusts left much heavier residues of copper and they were the most efficient fungicides also, but a similar

correlation did not hold for the other dusts. Of the six dusts used, Bordow No. 1 for example, ranked third in effectiveness but sixth in the quantity of copper left on the leaflets. From these results it seems improbable that the inclusion of a sticking agent in the dust fungicides would greatly improve their effectiveness.

The superior sticking quality of bordeaux mixture has been noted in previous tests and was suggested as the basis for its top rank as a celery fungicide. The copper analyses seem to support this contention since the quantities of residual copper on the leaflets from plots sprayed with either 8-12-100 or 8-6-100 bordeaux were greatly in excess of those on the plants treated with other fungicides. As in the dusted plats, however, a similar correlation could not be traced through the series. Grasselli Copper A, for example ranked next to bordeaux in effectiveness and yet left the smallest residue of copper on the leaves. It is evident that factors other than adherence of the fungicide to the foliage are important in determining fungicidal efficiency. It is also apparent from these analyses that copper injury is not directly related to the quantity of copper in the residues. The bordeaux sprays left the heaviest deposits of copper and caused no perceptible injury while Grasselli Copper A, leaving the lightest copper residue, caused as much injury as other insoluble copper materials which adhered to the foliage in larger quantities.

Discussion

The favorable results obtained with the copper-sulphur-talc dusts in 1938 provide a basis for further experiments with combinations of these materials as substitutes for the copper sulphate-lime dusts. While the Cuprocide-sulphur-talc dust was the most satisfactory, it is probable that with further experimentation, other equally effective combinations may be prepared. With the Cuprocide dust consistently controlling leaf blights better than the copper sulphate-lime combinations in 1938, there is justification for extending the tests of this fungicide in 1939.

No substitute for bordeaux mixture has yet been developed that controls leaf diseases as well or causes less injury to the celery plant. With the exception of Copper A, the copper materials of low solubility used in the 1938 tests failed to control leaf blights satisfactorily and all of them caused perceptible injury. Hydrated lime or zinc sulphate failed to prevent injury to the foliage by basic copper sulphate. Unless additional tests reveal combinations superior to those used in the 1938 experiments, Michigan celery growers who use liquid fungicides should continue to rely on standard 8-12-100 bordeaux for protecting their crop against leaf diseases. The results with 8-6-100 bordeaux indicate that it may be safe to reduce the quantity of lime by one-half in the standard formula, but this cannot be recommended on the basis of one season's test. Experiments with bordeaux sprays containing even smaller quantities of lime will be carried on in conjunction with further tests of the 8-6-100 combination in 1939.

Summary

The results of dusting and spraying experiments for comparing the value of old and new materials for control of celery leaf blights are presented.

Cuprocide-sulphur-talc dusts gave superior control of leaf blights in 3 plantings of celery at Comstock. These dusts had smoother flowing properties and covered the foliage better than did any materials previously tested. Basicop-sulphur-talc and Bordow-sulphur-talc dusts were less satisfactory than Cuprocide, but about equal in effectiveness to copper sulphate-lime and copper sulphate-lime-talc combinations.

Bordeaux 8-12-100 and 8-6-100 controlled leaf diseases without perceptible injury to the foliage more effectively than the copper fungicides of low solubility, all of which caused sufficient injury to reduce yields. Grasselli Copper A was an effective fungicide but it caused injury to the foliage which was reflected in lower yields than those obtained from the bordeaux plats. Hydrated lime or zinc sulphate failed to prevent injury to the foliage by Basicop sprays.

Bibliography

1. Hibbard, Rufus P., Grigsby, B. H., and Keck, W. G. A low light intensity photoelectric device for the determination of leaf areas. Papers of the Mich. Acad. Sci. Arts and Letters **23:** 141-147. 1937.
2. Nelson, Ray and Cochran, L. C. Copper dusts control celery early blight. Mich. Agr. Exp. Sta. Quar. Bul. **18:** 163-169. 1936.
3. ———— and Lewis, Ralph W. Comparative effectiveness of copper dusts in the control of celery leaf blights in 1936. Mich. Agr. Exp. Sta. Quar. Bul. **19:** 159-162. 1937.
4. ————————. Comparisons of fungicides for control of celery leaf blights. Mich. Agr. Exp. Sta. Quar. Bul. **20:** 210-221. 1938.

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BULLETIN REVIEWS

Cir. Bul. 168—Production of Root Crops for Forage in Michigan— Churchill, B. R.—Root crops are valuable as succulent feed in the Upper Peninsula and the northern part of the Lower Peninsula. Rutabagas have done best in the cooler sections of the state while mangels have been most satisfactory in the corn-growing areas. Root crops should be grown on the same land only once in three or four years. They should preferably follow a sod crop and they respond with increased yields to applications of commercial fertilizer or barnyard manure. Based on trials at the Upper Peninsula Experiment Station at Chatham, recommendations are given for tillage practices, row widths, seeding rates, insect control, harvest and storage methods. (16 pp., 4 tables, 6 figs.)

Cir. Bul. 169—Marketing Michigan Vegetable Crops—Gaston, H. P.—Data are presented on the influence of varietal differences, sizes, grades and methods of packaging on sales and prices for common vegetable crops, such as cabbage, tomatoes, carrots, cantaloupes, beets. (22 pp., 7 figs.)

Spec. Bul. 297—Profitable Dairy Management—Wright, K. T. and Baltzer, A. C.—This study was based upon 499 dairy records obtained in 1932-36. The farms averaged 159 acres with 80 per cent of the acreage in feed crops. The average amount of livestock on the farms was 13 cows and accompanying young stock, 9 ewes, 118 hens, and slightly less than one sow. Average annual feed consumption per cow was approximately 1 ton of concentrates, 1.5 tons of hay, 2.7 tons of silage and other roughage and 166 days of pasture. Average annual labor required for feeding, milking and other care was 154 hours per cow. The average annual cost per cow was $140, including feed cost $57, labor $29, management $14, use of buildings and equipment $9, and other items $31. The cows averaged 339 pounds of butterfat a year. Income averaged $134 per cow. Thus the income from each cow lacked $6 of paying costs. Included in the costs is a labor and management charge of 28 cents an hour for labor on the cows. The income was, therefore, only 24 cents an hour for all time spent, or $37.08 labor and management return from each cow.

The farm cost of producing 100 pounds of milk was $1.79. Feed cost constituted 41 per cent of the total, feed prices being relatively lower than some other cost items during this time. Income from dairy products sold as milk, cream or butter, averaged $1.49 per hundred pounds of 4.3 per cent milk. Other credits increased that to $1.71, or 8 cents a hundred less than the farm costs of production.

The low-producing herds in this study, averaged 214 pounds of butterfat per cow, had a total yearly cost of about $107 a cow and paid a labor and management return of $16 a cow, or 11 cents an hour. High-producing herds, averaged 432 pounds of butterfat per cow, had a yearly cost of nearly $163 a cow, and paid a labor and management

return of about $52 a cow, or 31 cents an hour. The cost of producing butterfat was one-fourth, or 12 cents a pound, lower on the high-producing herds, even though twice as much management charge was included.

Many factors influenced the cost of producing a pound of butterfat, or a hundred pounds of milk. The low-cost one-fifth of the herds in this study produced a pound of butterfat at a cost of 32 cents, compared with 53 cents for the high-cost one-fifth. This would make a difference of about $70 in the annual return per cow in those herds which averaged 340 pounds of butterfat.

The lower butterfat costs on the more efficient herds, was about a fourth due to the 72 pounds higher butterfat production per cow, and three-fourths due to a $39 lower annual cost per cow. The factors responsible for the lower cost were: (1) more efficient feeding, (2) handling the herd with less labor, and (3) managing the herd so there was less depreciation per cow. (56 pp., 26 tables, 23 figs.)

Spec. Bul. 298—Interests of Rural People as Portrayed in Weekly Newspapers—Hoffer, C. R.—A classification and measurement of the content in a sample of 540 issues of weekly newspapers from 35 different communities in Michigan showed that local community news constituted 69.9 per cent of the total news space, general news 12.0 per cent, county news 9.9 per cent, and state news 8.2 per cent. When the local news was classified according to the percentage of space filled by different types of news, the following order was found: neighborhood news (which was mainly personal news items), personal, agriculture, school, church, civic and patriotic affairs, recreation, adult education, business, and health. The analysis of the editorials showed that a great number and variety of subjects were considered, though community development and cooperation received more emphasis than any other topic. (30 pp., 9 tables, 3 figs.)

Tech. Bul. 162—The Relative Importance of Various Factors Influencing Profits in Strawberry Production—Peacock, N. D.—A digest of the literature on strawberry production, together with a report on both field surveys and plot experiments to determine the relative importance of such factors as variety, source and size of plants, planting methods, soils, fertilizers, cultivation, mulching and renovation methods. Though all cultural practices and environmental conditions studied were found to influence plant growth and production and likewise production costs, returns and profits, the study as a whole emphasized the outstanding importance of a stand of plants in determining the success or failure of the enterprise. Beneficial effects of proper preparation of the plant bed, careful setting and early care of the plantation are evident as long as the plantation remains; conversely, no amount of subsequent attention will compensate for lack of those things before, at and immediately after planting. (75 pp., 31 tables.)

JOURNAL ARTICLE ABSTRACTS

Variations in the Number of Vertebrae of Swine.—Freeman, V. A.—Jour. Heredity. 30 (2): 61-64. 1939. [Journal Article No. 191 (n. s.) from the Michigan Agricultural Experiment Station.] A study was made of the variations in the number of thoracic and lumbar vertebrae in 182 pigs of the Michigan State College herd. Variation in number was found in all five breeds ranging from 19 to 23 so-called "body-vertebrae," with the extra number sometimes in the lumbar region and sometimes in the thoracic and associated with extra ribs. The difference in numbers of "body-vertebrae" found in males and females was not significant. The bacon-type Yorkshires had an average of .75 ± .081 more vertebrae than the Duroc Jerseys. Marked variations occurred within pigs of the same litter. Short ribs and small extra ribs were found.

Vertebrae counts were reported on 342 carcasses. Large numbers of "body-vertebrae" were associated with increased length of body. It was concluded that selection for length of body by usual methods has resulted in some increase in number of "body vertebrae".

The Use of Analysis of Co-Variance and Its Limitation in the Adjustment of Yields Based Upon Stand Irregularities.—Mahoney, C. H. and Baten, W. D.—Jour. Agr. Res. 58(5): 317-328. 1939. [Journal Article No. 326 (n. s.) from the Michigan Agricultural Experiment Station.] A method of correcting individual plot mean yields on the basis of stand suggested by Miles and Bryan was used in adjusting 108 individual randomized plots of sweet corn hybrids grown in 1937 where the "F" value before adjustment was highly significant for yield and stand respectively. The variances were reduced by adjustment but the efficiency of the method is evident in the reduction of the standard error of the experiment. Before adjustment there were three hybrids significantly higher, 5 significantly lower, and 18 non-significant as compared to open pollinated Golden Bantam. After adjustment there were two hybrids higher, 6 hybrids lower, and 18 neither significantly higher nor lower than Golden Bantam.

A much shorter and less laborious method for calculation of a new analysis of variance, suggested by Saunders, was likewise applied to the same corn data. It was found that if the adjusted plot means were carried out to two decimal places and the regression coefficient to four in the first method that the adjusted sum of squares derived by both methods would check approximately.

An example, using data from 1935 hybrid trials, is given to show that in the absence of correlation between yield and stand and with non-significant "F" values that nothing was gained by adjustment.

Another example is presented to show that, in the absence of a significant "F" value for treatment on tomato fertilizer tests and with an insignificant correlation between yield and stand, adjustment was efficient. Before adjustment three treatments approached the 5 per cent

point of significance, when compared to the check, and adjustment changed the means of the high yielding treatments and decreased the means of the low yielding treatments sufficiently to make these three means significant beyond the 5 per cent point.

Another example is presented where the treatment "F" is significant and the stand "F" approaches significance, but with one exception none of the means shows significant differences compared to the check. These data are taken from the 1937 fertilizer placement tests on Refugee beans grown for canning.

The Response of Quack Grass to Variations in Height of Cutting and Rates of Application of Nitrogen.—Johnson, A. A., and Dexter, S. T. Jour. Am. Soc. Agron. 31(1): 67-76. 1939. [Journal Article No. 338 (n. s.) from the Michigan Agricultural Experiment Station.]

Quack grass *(Agropyron repens)* was grown in sand cultures in the greenhouse with and without nitrogen. The cultures were cut weekly over a period of 24 weeks at heights ranging from the level of the sand to 8 inches above the sand. At the end of 24 weeks the high-nitrogen, close-cut cultures were dead while the low-nitrogen, close-cut cultures were still alive and had ⅓ of the original rhizome weight left. Cutting cultures high in nitrogen at the one-inch level was very injurious while the same treatment to low-nitrogen cultures caused only small injury. Minus-nitrogen quack grass plants stored organic reserves in subterranean parts at a more severe cutting level than did plus-nitrogen plants.

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